# PALEONTOLOGY.

# PALÆONTOLOGY.

## VAN CLEVE'S FOSSIL CORALS.

IDENTIFIED AND COMPILED
BY PROFESSOR JAMES HALL.

This work is a continuation of that by Dr. C. A. White, in the previous report for 1881, and is published with the desire of preserving some of Mr. Van Cleve's work on the fossil corals. The engraved plates and manuscripts of Mr. Van Cleve have been compared with the published descriptions of American corals, and the species identified so far as possible. The descriptions of the species have been compiled largely from their original sources. These, with the accompanying illustrations, will enable the student to identify many of the common and characteristic forms of the fossil corals of Indiana.

A list of the species published in the previous report is herewith given; and, also, those of the present paper, with references to the MSS. names of Mr. Van Cleve.

The labor of comparison and arrangement of the material has been principally done by Mr. C. E. Beecher, under my dictation and supervision.

List of species published in the Indiana Geological Report for 1881:

LOWER SILURIAN.

*Streptelasma corniculum*, Hall.
*Palæophyllum divaricans*, Nicholson.
*Favistella stellata*, Hall.
*Protarea vetusta*, Edwards & Haime.
*Constellaria antheloidea*, Hall.
*Monticulipora frondosa*, D'Orbigny.

UPPER SILURIAN.

*Lyellia americana*, Edwards & Haime.
*Halysites catenulata*, Linnæus.
*Heliolites elegans*, Hall.
*Favosites favosus*, Goldfuss.
*Cladopora reticulata*, Hall.
*Clathropora frondosa*, Hall.

DEVONIAN.

*Acervularia davidsoni*, Edwards & Haime.
*Diphyphyllum archiaci*, Billings.
" *stramineum*, Billings.
" *arundinaceum*, Billings.
*Eridophyllum strictum*, Edwards & Haime.
*Cystiphyllum vesiculosum*, Goldfuss.
*Zaphrentis rafinesquii*, Edwards & Haime.
*Amplexus yandelli*, Edwards & Haime.
*Favosites basaltica*, Goldfuss.
" *polymorpha*, Goldfuss.
" " var. *dubia*, Goldfuss.
*Fistulipora canadensis*, Billings.
*Alveolites goldfussi*, Billings.
*Striatopora linnæana*, Billings.
*Syringopora perelegans*, Billings.
" *maclurei*, Billings.
*Stromatopora pustulifera?* Winchell.

LOWER CARBONIFEROUS.

*Lithostrotion mammillare*, Castelnau.

In the present paper the following species are described, or referred to:

TRENTON LIMESTONE.

*Receptaculites oweni* Hall = *Coscinopora sulcata*, (Goldfuss), Van Cleve.

## CORALS.

### HUDSON RIVER GROUP.

*Favistella stellata*, Hall=*Astrea prismatica*, Van Cleve.

*Monticulipora discoidea* James=*Ceriopora orbiculata*, Van Cleve.

" *gracilis*, James=*Ceriopora tenuis*, Van Cleve.

" *jamesi* Nicholson=in part, *Ceriopora multiformis*, Van Cleve.

" *andrewsi* Nicholson=in part, *Ceriopora multiformis*, Van Cleve.

" *ulrichi* Nicholson=in part, *Ceriopora multiformis*, Van Cleve.

" *dalii* Edwards & Haime=in part, *Ceriopora muricata*, Van Cleve.

" *mammulata* D'Orbigny.=in part, *Ceriopora muricata*, Van Cleve.

" *approximata*=Nicholson *Ceriopora mammulata*, Van Cleve.

" *tuberculata*=Edwards & Haime=*Ceriopora tuberculata*, Van Cleve.

*Palæophyllum divaricans* Nicholson=*Cyathophyllum dianthus*, (Goldfuss), Van Cleve.

### NIAGARA GROUP.

*Heliolites interstinctus*, Linne=*Astrea porosa*, (Goldfuss), Van Cleve.

*Lyellia americana* Edwards & Haime=*Astrea vesiculosa*, Van Cleve.

*Favosites favosus* Goldfuss=*Calamopora favosa*, (Goldfuss), Van Cleve.

*Thecia major*, Rominger=*Astrea septa*, Van Cleve.

*Syringopora verticillata* Goldfuss=*Syringopora verticillata*, (Goldfuss), Van Cleve.

*Aulopora vanclevii* Hall=*Aulopora serpens*, (Goldfuss), Van Cleve.

*Eridophyllum rugosum* Edwards & Haime.=*Lithodendron larviformis*, Van Cleve.

CORNIFEROUS LIMESTONE.

*Favosites emmonsi*, Rominger=*Calamopora* ——, Van Cleve.

" *limitaris*, " " *spongites* (Goldf.), "

" *hemisphericus* Yandell & Shumard=*alveolaris*, (Goldfuss), Van Cleve.

*Syringopora perelegans* Billings=*Syringopora cæspitosa*, (Goldfuss), Van Cleve.

*Heliophyllum halli* Edwards & Haime=*Cyathophyllum turbinatum*, (Goldfuss), Van Cleve.

*Heliophyllum coalitum*, Rominger. = *Cyathophyllum helianthoides*, (Goldfuss), Van Cleve.

*Cyathophyllum rugosum*, Edwards & Haime. = *Cyathophyllum hexagonum*, (Goldfuss), Van Cleve.

*Diphyphyllum stramineum*, Billings. = *Lithodendron flexuosum*, Van Cleve.

*Eridophyllum verneuilianum*, Edwards & Haime. = *Lithodendron verticillatum*, Van Cleve.

*Eridophyllum simcoense*, Billings. = *Lithodendron vemiculare*, Van Cleve.

*Cystiphyllum pustulatum*, Hall. = *Cyathophyllum vesiculosum*, (Goldfuss), Van Cleve.

*Syringostroma densum*, Nicholson. = *Agaricia boletiformis*, (Goldfuss), Van Cleve.

## BRYOZOA.

HUDSON RIVER GROUP.

*Ptilodictya falciformis*, Nicholson. = *Ceriopora ensiformis*, Van Cleve.

CLINTON GROUP.

*Ptilodictya expansa*, Hall & Whitfield. = *Ptilodictya lanceolata*, (Goldfuss), Van Cleve.

*Ptilodictya bipunctata*, Van Cleve. = *Ptilodictya bipunctata*, Van Cleve.

*Stictopora compressa*, Van Cleve. = *Eschara compressa*, Van Cleve.

*Stictopora bifurcata*, Van Cleve. = *Eschara bifurcata*, Van Cleve.

*Stictopora Van clevii*, Hall. = *Eschara ramosa*, Van Cleve.

*Stictopora multifida*, Van Cleve. = *Eschara multifida*, Van Cleve.

*Retepora angulata*, Hall. = *Retepora producta*, Van Cleve.

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## TRENTON LIMESTONE.

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## PROTISTA.

### RECEPTACULITES, *De France.*

#### RECEPTACULITES OWENI.

*Plate* 1, *Fig.* 1.

*Receptaculites Oweni*, HALL. Geological Report, Wisconsin, 1861.
*Coscinopora sulcata* (Goldfuss), VAN CLEVE MSS., 1853.

Specimens of this species were obtained from the lead-bearing rocks of Iowa, and identified with *Coscinopora sulcata*, of Goldfuss, by Mr. Van. Cleve. Dr. Owen had previously made the same identification, and termed the lead-bearing rock as the "Coscinopora beds." (Report on the Mineral Region of the Northwest, p. 40, 1844.)

*Original Description.*—Body consisting of a broad, expanded disc, from four to twelve inches in width, and from one-quarter to half an inch in thickness (rarely a little thicker); surface undulating, with an abrupt funnel-shaped depression in the center of the upper side, from which the cell-rows radiate in curved lines.

The thickness in the center is not more than one-eighth of an inch, and at a distance of three or four inches from the center is less than half an inch; cells cylindrical in the middle and contracted above and below, the walls of the cavities often showing transverse striæ, which appear like the remains of

septa. The distance of the cells from each other is variable, those near the center being closer together, though, in receding from the center, there are, at intervals, intercalated rows of cells, which take the same direction, and give the cells a closer arrangement toward the margin than in the intermediate space before the intercalation of the additional rows. The apertures, both above and below, are essentially rhomboidal; but in well preserved surfaces there are remains of rays, which, however, are rarely observed, and I have not seen them on the opposite sides of the same specimen.

The various stages of decomposition, and degrees of preservation, present a great variety of surface aspect. In some conditions there is visible a distinct groove, extending along the surface from one cell to the next, across the curving interspaces.

*Geological Formation and Localities.*—In the Galena limestone of Wisconsin, Northern Illinois, and the eastern part of Iowa, this fossil is everywhere present, and is the most marked and characteristic form in the rock.

Specimens of *Receptaculites* are found in the Niagara group of Indiana. They offer such varied conditions of preservation, and their true nature and structure is so little understood, that extracts from a paper by Mr. Billings upon this subject are here introduced, giving the results of comparisons between a number of species and many individuals. The paper in question appeared in the "Canadian Naturalist" for June, 1865.

"The genus may be described as consisting of organisms, which, when full-grown and perfect, are of a discoid, cylindrical, ovate or globular shape, hollow within, and usually, if not always, with an aperture in the upper side. In or near the center of the lower side there is generally to be seen a small rounded protuberance, indicating, most probably, the position of the primitive cell or nucleus from which the animal commenced its growth. In some species the lower side is more or less concave, and often the nucleus is not at all elevated above the surface adjacent thereto. Its place, however, in the absence of any other guide, may generally be found by observing the point toward which the spiral lines or rows of plates on the outer surface converge. The body-wall is of a somewhat complex structure. It consists of three parts—an external and an internal integument, and, between these, the peculiar tubular or spicular skeleton presently to be described. The external integument may be called the 'ectorhin,' and the internal the 'endorhin.'"

"The ectorhin is usually composed of numerous small rhomboidal plates, closely fitting together, and arranged in curved rows, which radiate in all directions from the nucleus outward to the peripheral margin of the base, and thence, ascending, converge to the edge of the aperture in the upper side. Two or three of these rows of plates (the precise number is not yet determined) originate in the nucleus, and, as they diverge from each other, new rows are introduced between them. The number of rows diminish again on the upper side according as they converge toward the apex of the fossil. The plates at and immediately around the nucleus, and also toward the center of the upper side, are somewhat smaller than they are at the widest part or middle region of the body. It seems probable that, in some of the species, this integument was of a flexible, coriaceous consistence. In others, the plates were solid. In *R. occidentalis* (Salter), when silicified specimens are treated with acid, the plates are easily separable; and, therefore, although in close contact, they are not anchylosed together.

"The endorhin is also composed of small rhomboidal plates, arranged in curving rows, but it differs from the ectorhin in being perforated by numerous small circular orifices, one of which is situated at each point where the angles of four plates meet. From the center of each of the plates of this integument there radiate four small canals, one proceeding straight to the middle of each of the sides of the plate, where it communicates with a similar canal in the adjoining plates. Each of these plates is, therefore, connected by these canals with the four plates in contact with it. The canals are excavated in the substance of the plates, and communicate with the central canal of the transverse tubes. The canals are not always perfectly circular, but are often flattened or irregularly circular. The endorhin varies greatly in the extent to which it is developed. In some specimens the plates are well defined and rhomboidal, with perfectly circular pores at the angles. In others the plates are not at all defined, the ectorhin being one continuous integument without sutures, but always with the full complement of pores. The latter, in such specimens, are not all circular, but are variously shaped orifices, sometimes with rough edges. There are also specimens in which the endorhin consists of only a thin film capping, as it were, the tubes and inclosing the canals, the pores being proportionally larger than they are in those with well-developed plates. The end of each tube in these specimens forms an irregular, rounded tubercle, instead of a rhomboidal plate."

"The tubular skeleton, above alluded to, consists of numerous small, straight, rarely curved, cylindrical tubes or hollow spicula, placed parallel to each other and at right angles to the

plane of the body-wall, of which they form the greater portion. They connect, and at the same time keep asunder the ectorhin and the endorhin. One of these tubes springs from the center of each plate of the ectorhin. It is, at its base, or next to the ectorhin, very slender, but enlarges so as to attain its full thickness at about one-fourth of its length, and then remains at the same diameter throughout until it reaches the endorhin, by a single plate, of which its inner extremity is, as it were, capped. The outer extremity of each tube has four slender stolons, one proceeding to each of the four angles of that particular plate of the ectorhin from the center of which it (the tube) springs. It there seems to form a connection with the stolons of the three adjacent plates, whose angles meet at that point. The stolons are so arranged that one of them always points inwards towards the nucleus, and another, on the opposite side of the tube, outwards or upwards. It is proposed to call these the radial stolons; they form continuous lines, radiating in all directions away from the nucleus. The other two stolons of each tube project at right angles to the direction of the radial stolons; they form circles around the nucleus, and may, therefore, be called the cyclical stolons. The connection of all these different parts may be better understood by studying the following figures:"

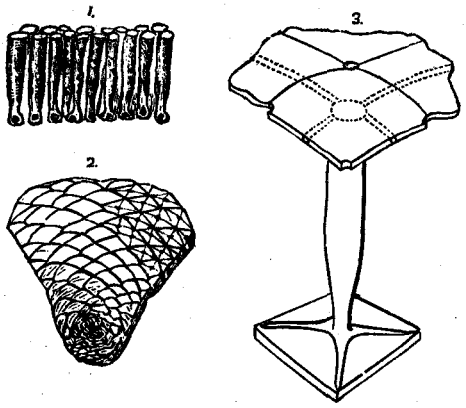



Figure 1, is of a small portion of the body-walls, broken transversely to show the tubes and the apertures of the hollow stolons. Figure 2 represents the usual appearance of the lower portion. One corner of the specimen is represented as denuded of the ectorhin, showing the characters beneath, which are explained by reference to figure 3, which is a diagramatic restoration, showing the features described above. These figures are somewhat abridged from those given in the "Canadian Naturalist."

# POLYPI.

## HUDSON RIVER GROUP.

## COLUMNARIA, GOLDFUSS.

## FAVISTELLA, HALL.

### FAVISTELLA STELLATA.

*Plate* 1, *Figs.* 2, 3, 4.

*Favistella stellata*, HALL. Pal. N. Y. vol. i, 1847.
" " " WHITE. Geology and Natural History of Indiana, 11th Report, 1881, p. 378.

The figures of this species on plate 1, are given in addition to those identified by Mr. White, and serve to further illustrate this characteristic species of the Hudson River group.

This species is abundant in the upper part of the Hudson River Group at Madison and other localities in Indiana.

## MONTICULIPORA,* *D'Orbigny.*

### MONTICULIPORA DISCOIDEA.

*Plate* 10—*Figs.* 4, 5.

*Chætetes discoideus*, JAMES. Cat. Low. Sil. Foss., 1871.
" " " NICHOLSON. Pal. Ohio, vol. ii, p. 206, 1875.
*Ceriopora orbiculata*, VAN CLEVE MSS., 1853.

"Corallum free, discoid, sharp-edged, concavo-convex, from five to eight lines in diameter, and from one to nearly two lines in greatest thickness. Under surface concave, covered with a very thin epitheca, which but for one or two obscure concentric wrinkles, is nearly smooth, and which is in general so delicate as to reveal clearly through its substance the bases of the superjacent corallites. Upper surface gently convex, not ex-

*The following species have been described under the genus Monticulipora, and some of them have been more recently arranged by Nicholson under new subgeneric designations Other subgenera have also been proposed by Mr. Ulrich, and there is still a want of agreement among the several authors who have described the species of this group of fossils. The material at the disposal of the writer for the present purpose does not afford the means for critical discussion, nor is the subject, under any circumstances, an inviting one at the present time.

hibiting any tubercles or elevations of any kind. Corallites sub-equal, the larger ones usually scattered irregularly amongst the smaller ones, and rarely aggregated into distinct groups. Calices with moderately thin walls, polygonal or sub-circular, from eight to ten in the space of one line. The ordinary corallites are not separated by any system of minute intermediate tubuli." (Nicholson Pal. Ohio, vol. ii, p. 206, 1875.)

*Formation and Localities.*—In the Hudson river group of Indiana and Ohio.

### MONTICULIPORA GRACILIS.

*Plate* 10, *Figs.* 1, 2, 3, *and Plate* 11, *Fig.* 11.

*Chætetes gracilis*, JAMES. Cat. Foss. Cincinnati Group. 1871.
*Ceriopora tenuis*, VAN CLEVE MSS., 1853.

"Corallum dendroid, the branches solid or hollow, cylindrical or sub-cylindrical, dividing dichotomously at short intervals and at very acute angles (usually from 25° to 40°), from less than one line to two lines or more in diameter. Corallites very small, from ten to twelve in the space of one line, opening obliquely on the surface by oval or sub-triangular calices, the walls of which are separated by very distinct lines of demarkation, and between which are placed more or fewer very minute tubuli. The surface shows no elevations or tubercles, but is entirely smooth, and altogether destitute of any groups of large-sized corallites. The margins of the calices are sometimes finely granulated. This species may, in general, be distinguished by the oval, or rounded, thick-walled calices, and the minute dimensions of the ordinary corallites, together with the marked obliquity of the corallites to the surface, and the very acute angle at which the stems bifurcate." (Nicholson, Pal. Ohio, vol. ii, p. 198, 1875.)

*Formation and Localities.*—Hudson River group, Indiana and Ohio.

### MONTICULIPORA JAMESI.

*Plate* 11, *Fig.* 8.

*Chætetes Jamesi*, NICHOLSON. Pal. Ohio, vol. ii, p. 200, 1875.
In part *Ceriopora multiformis*, VAN CLEVE MSS., 1853.

"Corallum of cylindrical or sub-cylindrical, usually hollow branches, the diameter of which is from three to five lines, or of lobate or sub-palmate masses, the extremities of which are rounded. Branches, in the ramose examples, dividing dichotomously at varying intervals, irregularly thickened and nodulated. Corallites oval, circular, or sub-polygonal in section, of

unequal sizes. The larger corallites are about six in the space of one line, with extremely thick walls, the margins of the oval or rounded calices being generally obscurely tuberculated or granulated. The large corallites are occasionally separated by extremely minute cylindrical tubuli, which vary in number in different specimens, or in different parts of the same specimen, their presence, however, usually being a little conspicuous. The surface exhibits no eminences or tubercles of any kind, nor are there any groups of large sized corallites; but typical specimens exhibit, at irregular intervals, stellate spaces, which are either solid or minutely punctate, and which have a diameter of about two-thirds of a line." (Nicholson, Pal. Ohio, vol. ii, p. 200, 1875.)

*Formation and Localities.*—Hudson River group, Ohio and Indiana.

### MONTICULIPORA ANDREWSI.

*Plate* 11, *Fig.* 9.

*Monticulipora andrewsi*, NICHOLSON. Structure and affinities of Monticulipora, 1881.
In part *Ceriopora multiformis*, VAN CLEVE MSS., 1853.

### MONTICULIPORA ULRICHI.

*Plate* 11, *Fig.* 10.

*Monticulipora ulrichi*, NICHOLSON. Structure and affinities of Monticulipora, 1881.
In part *Ceriopora multiformis*, VAN CLEVE MSS., 1853.

### MONTICULIPORA DALII.

*Plate* 11, *Fig.* 2.

*Chætetes dalii*, E. & H. Pal. Foss. des Terr. Pal., 1851.
In part *Ceriopora muricata*, VAN CLEVE MSS., 1853.
*Monticulipora ramosa*, E. & H., as identified by some authors.

"Corallum branching, the stems cylindrical or elliptical, diverging dichotomously at short intervals, sometimes reticulating their average diameter when full grown from three to four lines, but when immature from one to two lines. Calices in general, six to eight in the space of one line, polygonal, with moderately thick walls. A greater or less number of exceedingly small calices always intercalated among the ordinary corallites. Surface covered with conical, often sharply pointed, rarely transversely elongated eminences or tubercles, which sometimes attain a height of more than half a line, and which are placed at distances apart of from half a line to nearly one line. Commonly these eminences are arranged in irregular

diagonal lines, and they are always occupied by corallites which do not exceed the average in point of size. The summits of the tubercles, indeed, are not unfrequently solid, or are occupied by corallites of less than average size." (Nicholson, Pal. Ohio, vol. ii, p. 192, 1875.)

*Formation and Localities.*—Hudson River group, Indiana and Ohio.

### MONTICULIPORA MAMMULATA.

*Plate* 11, *Fig.* 1.

*Monticulipora mammulata*, D'ORBIGNY. Podr. de Paleont., 1850.
In part *Ceriopora muricata*, VAN CLEVE MSS., 1853.

"Corallum forming irregular expanions of very considerable size, sometimes palmate or lobate, carrying the polypes on both sides; thickness of the corallum usually varying from two to four lines; surface covered with well-marked and prominent tuberosites, usually of a rounded or obtusely conical form, the elevation of which varies in different specimens. The tubercles are somewhat irregularly arranged, at intervals of one line to a line and a half apart, and they are covered with calices which are very slightly larger than the average, occasionally with some very minute tubes interspersed amongst them. The corallites are sub-equal, polygonal, with thin walls, from eight to ten in the space of one line. Very rarely one or two very minute calices may be detected at the angles of the average corallites." (Nicholson, Pal. Ohio, vol. ii, p. 207, 1875.)

*Formation and Localities.*—In the shales of the Hudson River group, Indiana and Ohio.

### MONTICULIPORA APPROXIMATA.

*Plate* 11, *Fig.* 6.

*Chætetes approximatus*, NICHOLSON. Pal. Ohio, vol. ii, p. 193, 1875.
*Ceriopora mammulata*, VAN CLEVE MSS., 1853.

"Corallum composed of cylindrical stems, from one and a half to nearly three lines in diameter, dividing dichotomously at short intervals. Corallites tolerably thick-walled, oval, subcircular, or polygonal in shape, from eight to ten in the space of one line, often with excessively minute corallites interspersed amongst them, though these are rarely as abundant as in the preceding forms, and may be nearly absent. Surface exhibiting a number of small conical or somewhat transversely elongated eminences, which are very slightly elevated above the general surface. These eminences are placed in irregular diag-

onal rows, separate about half a line transversely and two-thirds of a line measured vertically, and they are either solid at their summit or carry a few excessively small cylindrical tubuli, with or without one or more of the ordinary corallites." (Nicholson, Pal. Ohio, vol. ii, p. 193, 1875.)

*Formation and Localities.*—Hudson River group, Ohio and Indiana.

For reference to figures 3, 4, 5, 7, 12 and 13, see explanations of plate 11.

### MONTICULIPORA TUBERCULATA.

*Plate* 10, *Fig.* 6.

*Chætetes tuberculatus*, E. AND H. Pal. Foss. des Terr. Pal., 1851.
Compare *Chætetes corticans*, NICHOLSON. Pal. Ohio, vol. ii, p. 210, 1875.
*Ceriopora tuberculata*, VAN CLEVE MSS., 1853.

Mr. Van Cleve had intended giving the same specific name to this fossil as was published by Edwards & Haime. In his MSS. description he says:

"Forms a covering upon other fossils; the specimens thus far found having been in every case upon fragments of orthoceratites. The surface is set with carinate turbercles, alternating with each other in perpendicular ranges, and having their longer diameters in the direction of the ranges. The cell-mouths are equal, and cover alike the tubercles and the spaces between them."

*Formation and Localities.*—Hudson River group, Indiana and Ohio.

## PALÆOPHYLLUM, *Billings.*

### PALÆOPHYLLUM DIVARICANS.

*Plate* 1, *Fig.* 5.

*Cyathophyllum dianthus*, (Goldfuss,) VAN CLEVE MSS., 1853.
*Palæophyllum divaricans*, NICHOLSON. Pal. Ohio, vol. ii, 1875.
*Palæophyllum divaricans*, (Nicholson), WHITE. Geology and Natural History, Indiana, 11th Report, p. 377, 1881.

A description of this species is given in the Indiana Report, loc. cit.

# NIAGARA GROUP.

## HELIOLITES, *Guettard.*

### HELIOLITES INTERSTINCTUS.

*Plate* 2, *Figs.* 1, 2, 3.

*Madrepora interstincta*, LINNE. Syst. Nat., 1767.
*Astrea vesiculosa*, VAN CLEVE MSS., 1853.

Mr. Van Cleve's description probably refers to this species, although his figures are not perfectly clear. The description, as taken from his manuscript is as follows:

"Astrea fungiform, or somewhat branched; stars equal, distant, sunken; lamellæ few; interstices porous."

"This coral is found nodular, semiglobular, fungiform with stipes of various length, and occasionally in fragments exhibiting a branched structure. The entire surface is covered with small pores, like punctures of a needle, among which small, deep stars are sunken. They stand without order, rather distant from each other, and have only 12 or 14 slight lamellæ. The stars and pores are upon both the upper and lower surfaces, and upon the stipes of the fungiform specimens also."

*Formation and Localities.*—"Gravel, Dayton, silicious, Huntington, Indiana.

Specimens of this species are numerous in Indiana, Kentucky and Tennessee, and of less frequent occurrence in Michigan and other localities.

## LYELLIA, *Edwards & Haime.*

### LYELLIA AMERICANA.

*Plate* 2, *Figs.* 4, 5; *Plate* 3, *Fig* 7.

*Lyellia Americana*, E. & H. Mon. Pal. Foss. Terr. Pal., 1851.
*Astrea porosa*, (Goldfuss) VAN CLEVE MSS., 1853.
*Lyellia Americana*, (E. & H.) WHITE. Geology and Nat. Hist. Indiana, 11 Report, p. 381, 1881.

The figure given on plate 47 of the 11th Report (plate 3, fig. 7, of this Report) represents a much weathered specimen and special phase of the occurrence of this species. Figures 4 and 5 on plate 2, are enlargements, showing the structure of the corallum.

## THECIA, *Edwards & Haime.*

### THECIA MAJOR.

*Plate* 2, *Fig.* 6.

*Astrea septa*, VAN CLEVE MSS., 1853.
*Thecia major*, ROMINGER. Geol. Surv. Mich. Pal., p. 67, 1876.

The figure referred to this species on plate 2, has somewhat larger corallites than is common; but the description given by Mr. Van Cleve corresponds very closely with the original description of Dr. Rominger, which is as follows:

"Discoid lenticular expansions, covered on the lower side by a concentrically wrinkled epitheca, with diverging striæ, indicating the outlines of procumbent tubes, which bend into an erect position before they open on the upper surface of the disks. Diameter of tubes two millimeters, joining under well-marked, obtusely crested, polygonal margins, which inclose dilated artificial pits. Walls stout, but variable in thickness in different portions of the same specimens. Twelve radial crests extend half way to the centre; their edges are decorated with two rows of granulose spinules. Diaphragms numerous, partially flat, partially convex, forming a monticulose projection with spinulose or granulose surface. Pores large and abundant."

*Formation and Localities*—.In the Niagara group at Charleston Landing, and other localities in Indiana, and at numerous localities throughout the western extension of this formation.

## FAVOSITES, *Lamarck.*

### FAVOSITES FAVOSUS.

*Plate* 3, *Figs.* 1–4.

*Calamopora favosa*, GOLDFUSS. Petref. Germ., 1826.
*Calamopora favosa*, (Goldfuss), VAN CLEVE MSS., 1853.
*Favosites favosus* (Goldfuss), WHITE. Geology and Nat. Hist. of Ind., 11th Report, p. 383, 1881.

This species was previously identified among the plates of Mr. Van Cleve by Dr. C. A. White. The figures above referred to serve to illustrate this common and characteristic coral of the Niagara group.

### FAVOSITES (ASTROCERIUM) VENUSTUS.

*Plate* 2, *Figs.* 7, 8.

*Astrocerium venustum*, HALL. Pal. N. Y., vol. 2, p. 120, pl. 34, 1852.
——— ——— VAN CLEVE MSS., 1853.

The figures on plate 2, referred to this species, represent its ordinary characters. Figure 7 shows the cell apertures somewhat enlarged.

## SYRINGOPORA, *Goldfuss.*

### SYRINGOPORA VERTICILLATA.

*Plate* 3. *Fig.* 5.

*Syringopora verticillata*, GOLDFUSS. Petref. Germ., 1826.
*Syringopora verticillata*, (Goldfuss,) VAN CLEVE MSS., 1853.

"Large aggregations of parallel or diverging tubular stems, from two to three millimeters in diameter, keeping a distance of from two to five millimeters apart, across which they connect at various not very close intervals by narrow, transverse, branch tubules, of which two or three are always sent off at nearly the same height, but not in true verticillate position. The tubes are filled by invaginated, irregularly funnel-shaped diaphragms, attenuated at the lower ends into long siphons. The longitudinal rows of spinules are rarerly well preserved in the tubes of the specimens which are all found in silicified condition. The colonies of stems are often large, several feet in diameter; their basal portions, composed of prostrate, irregularly reticulated expansions of stems, differ considerably from the erect parts, and among the specimens of colonies a great many variations occur as regards the size of the tubes or their mode of growth. In some the stems are distant, in others near; in some perfectly straight, in others flexuose or geniculated with regular verticillate side connections or with dispersed side arms branching off at remote intervals or in closer proximity." (Rominger Geol. Survey, Michigan, pal. p. 80.)

The description and observations of Mr. Van Cleve on this species are of value and interest, and are here repeated in full.

"*Syringopora with straight, remote tubes; small connecting tubes sub-verticillate.*

"The cylindric, perpendicular and parallel tubes have the thickness of a stout raven quill and have the partitions within them close together. The side connecting tubes are almost verticillate. *Calcareous petrefaction, from Drummond's Island, Lake Huron.*

("*Gravel, Dayton.* In the specimens found here, there is more regularity in the positions of the whorls, than in the one figured by Goldfuss, their perpendicular distances from each other being less and more uniform and their horizontal extensions being almost in perfect planes. In consequence of this, the coral has the form and appearance of a very regular scaffolding.")

*Formation and Localities.*—Specimens may be met with at any of the productive localities of the Niagara limestone.

## AULOPORA, *Goldfuss.*

### AULOPORA VANCLEVII, *N. Sp.*

*Plate* 4; Figs. 1, 2.

*Aulopora serpens*, (Goldfuss), VAN CLEVE MSS., 1853.

From the description and figures of Mr. Van Cleve, we are led to consider his specimens as having been found in the Niagara Group of Indiana, and therefore differing from *A. serpens* belonging to the Devonian. His description is as follows:

"*Aulopora* incrusting, creeping; tubes narrow, proliferous from the side of the apex alternately or connected in network; orifices contracted, opening upward.

"The straight obconic tubes are proliferous near their upper ends, just below their mouths, which are round, slightly contracted and curved upwards. Either one tube sprouts from the preceding one, or two of them put forth, which then recede from each other in a fork, and then frequently unite again like a net by new sprouts and form meshes of different shapes and sizes."

There are specimens in the State collection from the Falls of the Ohio and vicinity, which agree very well with the above description and the figure on plate 4. *Aulopora serpens* is a much larger form, although of similar growth.

*Formation and Localities.*—Niagara Group, Indiana and Kentucky.

## ERIDOPHYLLUM, *Edwards & Haime.*

### ERIDOPHYLLUM RUGOSUM.

*Plate* 3, *Fig.* 6.

*Eridophyllum rugosum* E. & H. Mon. Pol. Foss. des Terr. Pal. 1851.
*Lithodendron larviformis*, VAN CLEVE MSS., 1853.

Cæspitose masses of cylindrical stems. Stems about ten millimeters in diameter, parallel, flexuous, with marked constrictions and numerous lateral, acanthiform processes of attachment. Lamellæ forty to fifty in each cup, crenulated.

*Formation and Localities.*—Quite common in the Niagara group of Indiana and Kentucky.

# CORNIFEROUS LIMESTONE.

## FAVOSITES, *Lamarck.*

### FAVOSITES EMMONSI.

*Plate* 4, *Figs.* 3, 4.

*Emmonsia hemispherica*, E. & H. Monog. Polyp. Foss. Terr. Pal. 1851.
*Calamopora* ——, VAN CLEVE MSS., 1853.
*Favosites emmonsi*, ROMINGER. Fossil corals, p. 27. 1876.
*Favosites emmonsi*, HALL. Illustrations of Devonian Fossils, pl. ix. 1876.

The original description of this species, loc. cit., is as follows:

"Tubes unequal, rounded-polygonal, from one to one and a half millimeters in diameter. Tube channels longitudinally striate by a cycle of twelve furrows; of the intermediate band-like spaces, each one bears a vertical row of horizontal squamæ, which are in alternating position in the adjoining rows. Diaphragms rarely simple, straight, generally composed of anchylosed, lateral squamæ, presenting an angular, substellate surface; or the interlacing squamæ remain free, and constitute imperfect septa instead of complete transverse diaphragms. Pores large, forming in single or double, or even triple rows on each side, according to its width, and in places they are much more numerous than in others. It is often noticeable that tubes, for a certain part of their length, are intersected by simple, straight diaphrams, without complication by lateral squamæ, and again, both above and below, are found divided by very irregularly interlacing compound septa. This form grows in large convex masses, or in discoid expansions, with a concentrically wrinkled epitheca on the lower side."

*Formation and Localities.*—This species is common in the Corniferous limestone of Indiana, and is also found in Kentucky, Ohio, Michigan, New York and Canada.

### FAVOSITES LIMITARIS.

*Plate* 4, *Figs.* 5, 6.

*Calamopora spongites* (Goldfuss), VAN CLEVE MSS., 1853.
*Favosites limitaris*, ROMINGER. Foss. Corals, p. 36. 1876.

"Ramified and reticulated stems, from five to fifteen millimeters in thickness, forming horizontally explanate expansions or erect fruticose ramifications. Tubes very thick walled, opening nearly rectangularly to the surface, with circular orifices, the walls forming either a solid, undefined interstitial mass; or,

in another state of preservation, the polygonal outlines of each tube are visible on the surface of the interstices as delicate engraved lines. Several varieties are observed in regard to the mode of growth, and the size of the tubes. The tube orifices rarely exceed the diameter of one millimeter; often they are smaller, and in some forms they are all equal in a specimen. Others have smaller and larger orifices intermingled. A part of the orifices of the side faces of the stems are often found closed by opercula, situated below the outer edge of the channels; in the interior parts of the tube channels diaphrams are not regularly developed, and are of rare occurrence. Pores large, distant, and irregularly dispersed. In older stems the tube channels not unfrequently become considerably narrowed by excessive incrassation of the tube walls, while the pore channels gain in length and width, and appear on the surface as vermicular, transverse channels connecting the tube channels, which latter are, in their narrowed condition, hardly larger than the connecting pore channels." (Rominger, Fossil Corals, p. 36.)

*Formation and Localities.*—Common to the Corniferous limestone in Indiana, Kentucky, Michigan, New York and Canada.

### FAVOSITES HEMISPHERICUS.

*Plate* 5, *Figs.* 1, 2.

*In part Calamopora alveolaris* (Goldfuss), VAN CLEVE MSS., 1853.
*Favosites hemisphericus*, YANDELL & SHUMARD. Contributions to the Geology of Kentucky. 1847.
*Favosites hemisphericus*, ROMINGER. Fossil Corals, p. 25, pl. vi. 1876.
*Favosites hemisphericus*, HALL. Illustrations of Devonian Fossils, pl. ii. 1876.
*Favosites turbinatus*, BILLINGS. 1859.
*Not Favosites hemisphericus*, EDWARDS & HAIME. 1851.

The description of this species, as limited and amended by Dr. Rominger, is as follows:

"The tubes of this form are about two millimeters in diameter, of unequal size, rounded polygonal. Tube cavity generally smooth, intersected by simple flat diaphragms. It occurs rarely that the diaphragms are compound and angular on the surface, formed by anchylosis of lateral squamiform projections. Lateral pores large, usually in a single row on each side, and moderately distant. Sometimes, however, two rows of pores may be observed on a side. The mode of growth mentioned as the most characteristic feature of this species is, nevertheless, quite variable. We find polyparia of subspherical or of biconvex lenticular form, or in cylindrical, irregularly flexuose, root-like masses, over a foot in length, or in elongated horn-

shape; all of which forms proceed from a single proliferous mother-tube. At first the polyparium is attached by its narrow and usually excentrical apex, but soon it becomes free, and the apex is folded over by the spreading margins of the rapidly enlarging corallum. The tubes diverge in graceful curves from an imaginary central axis toward the periphery. Those ends terminating on the lateral faces of the corallum, have their walls thickened in their peripheral portion, and their orifices are all closed by opercula of concentric annular structure, with a central opening while growing, which is finally closed by a solid nodular piece. The margins of the opercula are frequently decorated by twelve carinæ converging from the margins toward the centre, but not reaching it. In specimens with excessively thickened wall substance, these radial carinæ are very obscure or entirely obliterated. The orifices terminating on the convex disk of the corallum are all open, more thin walled than the others, and of more pronounced polygonal form. It often happens that these centrally situated, thinner walled tubes have been destroyed by weathering, while the exterior lateral tube ends, of massive structure, have resisted and been preserved. The upper end of such specimens is deeply excavated, and the lenticular forms are transmuted into concave, patelliform dishes. The elongated, horn-shaped specimens terminate in this case with a funnel-shaped excavation resmbling the calyx of a Cyathophyllum, which resemblance is augmented by the exposure of the side faces of the septate tubes, arching from the center to the periphery, which bear a descriptive likeness to the radial lamellæ, with intermediate vesicular cell spaces of the calyx of a Cyathophyllum." (Rominger, Fossil Corals, p. 25.)

*Formation and Localities.*—Common in the Corniferous limestone of Indiana, and throughout the extent of this formation in other States and in Canada.

## SYRINGOPORA, *Goldfuss.*

### SYRINGOPORA PERELEGANS.

*Plate 7, Fig. 1.*

*Syringopora cæspitosa*, (Goldfuss) VAN CLEVE MSS., 1853.
*Syringopora perelegans*, BILLINGS. Can. Jour., N. S., vol. iv. 1859.
*Syringopora perelegans*, (Billings) WHITE. Geol. Surv. Indiana, 11th Report, p. 398. 1881.

The original description of this species is given in the previous report. The present figure represents a compact mass of

corallites and agrees with the description of Billings, and the figures and description given by Dr. Rominger in his work on the fossil corals. The figure on plate 49 of the 11th Report, represents the tubes as considerably larger than usual with *S. perelegans*, and may represent another species.

## HELIOPHYLLUM, *Hall.*

### HELIOPHYLLUM HALLI.

*Plate* 6, *Fig.* 1.

*Heliophyllum halli*, E. & H. Brit. Foss. Corals. 1850.
*Cyathophyllum turbinatum*, (Goldfuss) VAN CLEVE MSS., 1853.

"*Corallum* simple, turbinate, or cylindro-conical, usually elongate, and slightly curved at its base, provided with an epitheca, and presenting slight circular swellings. *Calice* circular, rather deep, with a small septal fossula. *Septa* (80 or even more) very thin, closely set, rather broad at their upper end where they are arched and denticulate, alternately larger and smaller, slightly twisted near the center of the visceral chamber. A vertical section shows that the lateral processes of the septa are arched and ascendant; those situated toward the upper end of the corallum terminate at the edge of the septa; those situated lower down unite near the center of the visceral chamber, so as to constitute irregular *tabulæ*. The interseptal loculi are filled up with these lamellate processes, which are situated at about half a line apart, and united by closely-set simple dissepiments that form right angles with them. Diameter of the calice from 1 to 2 inches."

[Edwards & Haime, monograph of the British Fossil Corals, 4th part, p. 235, 1853.]

Mr. Van Cleve's engraving gives a good representation of a fine specimen of this species.

*Formation and Localities.*—Common in the Corniferous limestone and Hamilton group of Indiana, Kentucky, Ohio, Michigan, New York and Canada.

### HELIOPHYLLUM COALITUM.

*Plate* 7, *Figs.* 2, 3.

*Cyathophyllum helianthoides*, (Goldfuss) VAN CLEVE MSS., 1853.
*Cyathophyllum coalitum*, ROMINGER. Fossil Corals. 1876.

"Astræiform masses of very large, polygonal polyp cells measuring about four centimeters in diameter, each one sur-

rounded by its own complete wall. Surface of calyces expanded, discoid, with an abrupt but shallow central pit, the reversed bottom of which conically projects, covered by the central ends of the radial crests. Lamellæ linear, sub-equal, from sixty to seventy in the circumference of a calyx, crenulated by transverse trabeculæ (bars), which are the ends of lateral, arched carinæ decorating the side faces; about fourteen carinæ on the length of one centimeter. Interstitial spaces filled with vesicles arranged in arched rows running diagonally across the carinations. Central area traversed by transverse, larger plates, which are much intersected by the vertical lamellæ." (Rominger, Fossil Corals, p. 108. 1876.)

*Formation and Localities.*—Frequently found among drift specimens from the Corniferous limestone.

Mr. Van Cleve has identified the simple and compound forms as one species, which he describes as follows: "Cyathophyllum solitary or cæspitose; terminal cell with margin broad, somewhat reflexed; in cæspitose specimens pentagonal; center widely umbilicate; rays in pairs, uniting in a disk."

It may be doubtful whether the simple and compound specimens are specifically identical.

## CYATHOPHYLLUM, *Goldfuss.*

### CYATHOPHYLLUM RUGOSUM.

*Plate* 8, *Figs.* 1, 2.

*Astrea rugosa*, HALL. Geol. Rept. 4th Dist., N. Y., 1843.
*Cyathophyllum rugosum*, E. AND H. Mon. Pol. Foss. des Terr. Palaeoz, 1851.
*Cyathophyllum hexagonum* (Goldfuss), VAN CLEVE. MSS., 1853.

"Astræiform colonies of polygonal, intimately united stems of a diameter from one to one and a half centimeter, which, in some specimens of a certain state of preservation, are separable, and present longitudinally ribbed polygonal stems, annulated by transverse wrinkles of growth. Calyces joining, with gradually ascending side walls, inclosing conical cell pits; or the end cells are formed by an abrupt, narrow, central pit, with horizontally expanded, discoid margins. The bottom of the cells is sometimes formed by diaphragms with a smooth central spot; usually the lamellæ reach to the center and intermingle there, forming a twisted knot. Number of lamellæ in the circumference of the calyces, from 35 to 45. Their edges are crenulated, the side faces traversed by arched carinæ, which, in some specimens, are almost obsolete; in others, very distinct.

Interlamellar interstices, traversed by small vesicles, filling them to the margins of the calyces. The center of the stems is transversely septate by diaphragms, intersected in their outer circumference by continuous vertical lamellæ; centrally their continuity is interrupted, and the ends are merely carinations on the upper face of the diaphragms." (Rominger, Fossil Corals, p. 106, 1876.)

*Formation and Localities.*—Common in the Corniferous limestone, in Indiana, Kentucky, Ohio and other localities.

## DIPHYPHYLLUM, *Lonsdale.*

### DIPHYPHYLLUM STRAMINEUM.

Plate 9, Fig. 2.

*Diphyphyllum stramineum,* BILLINGS. Canadian Journal N. S., vol. iv, 1859.
*Diphyphyllum stramineum,* WHITE. Geol. Rept. Indiana, 11 Report, p. 388. 1881.
*Lithodendron flexuosum,* VAN CLEVE MSS., 1853.

This species was identified among the engravings of Mr. Van Cleve, by Dr. White, in a previous report. The present figure represents a more compact form of the species.

*Formation and Localities.*—Corniferous limestone, Indiana, and in numerous other localities for this formation.

## ERIDOPHYLLUM, *Edwards & Haime.*

### ERIDOPHYLLUM VERNEUILIANUM?

Plate 8, Fig. 3.

*Eridophyllum Verneuilianum,* E. & H. Mon. Pal. Foss. des Terr. Pal., 1851.
*Eridophyllum Verneuilianum,* NICHOLSON. Pal. Ohio, vol. ii, p. 239.
*Lithodendron verticillatum,* VAN CLEVE MSS., 1853.

"Corallum composed of cylindrical, straight, or slightly flexuous corallites, which have a diameter of from four to six lines, and are united by horizontal connecting processes placed at intervals apart of from half an inch to one inch and a half. Septa usually about forty-five in number, alternately large and small, extending very nearly to the centre of the visceral chamber, and thus invading the central tabulate area. The septa are united in the outer zone of the corallites by numerous delicate dissepiments. The distance between the different corallites varies much, being sometimes as much as half an inch, whilst at other times the corallites are nearly in contact." (Nicholson, Pal. Ohio, vol. ii, p. 239.)

*Formation and Localities.* Corniferous limestone, Indiana, Kentucky and Ohio.

### ERIDOPHYLLUM SIMCOENSE.

*Plate* 9, *Fig.* 1.

*Eridophyllum Simcoense*, BILLINGS. Can. Jour. N. S., vol. iv, 1859.
*Lithodendron vermiculare*, VAN CLEVE MSS., 1853.

"Corallum forming colonies of cylindrical, straight, flexuous, or crooked corallites, from two to three lines in diameter, distant from one another from one to three lines, and united by short horizontal connecting processes at intervals varying from two to six lines. The connecting processes are thick where they spring from the wall of the corallite, thin in the middle, and again thick where they join the contiguous corallite; and they are often, though by no means universally, all turned the same way in the same colony. The surface usually exhibits encircling folds of growth, along with vertical ridges corresponding with the septa. There is a well developed central tabulated area, into which the septa penetrate slightly, or not at all. The septa are between forty and fifty in number, alternately large and small."

"Typical examples have the corallites straight, with the connecting processes placed at tolerably uniform distances, but many examples occur in which the corallites are very crooked, and the intervals between the connecting processes extremely variable. Increase by parietal gemmation, the young individual bending upwards and becoming parallel with the older corallites, is a phenomenon which can commonly be observed." (Nicholson. Palæontology of the Province of Ontario, p. 34, 1874.)

*Formation and Localities.*—Common in the Corniferous limestone at numerous localities throughout its extent.

## CYSTIPHYLLUM, *Lonsdale.*

### CYSTIPHYLLUM PUSTULATUM.

*Plate* 9, *Figs.* 3, 4? 5?

*Cystiphyllum pustylatum*, HALL. Foss. Corals Niag. and Up. Held. groups. In advance of Museum Report, p. 58. 1882.
*Cystiphyllum vesiculosum*, (Goldfuss) VAN CLEVE MSS., 1853.

Among the forms of Cystiphyllum figured by Mr. Van Cleve and referred by him to *C. vesiculosum* (Goldfuss), are the figures given on plate 9. Figure 3 represents the form and dimensions of *C. pustulatum* (Hall), of which the following is the original description:

"Corallum simple, turbinate, more or less rapidly expanding; proportional height and diameter varying; in some individuals of thirty-five millimeters in height the diameter of the calyx is fifty-five millimeters, in others, having a height of eighty millimeters, the diameter of the calyx is forty millimeters; exterior comparatively smooth, with concentric wrinkles and striæ, and distinct external costæ; calyx from twenty to thirty-five millimeters in depth, for a short distance from the margin, flat or gently curving, then abruptly and regularly sloping to the center; the entire surface of the calyx shows prominent cysts from one to three millimeters in diameter, increasing but little, if any, in size toward the center; occasionally a cyst occurs much larger than the ordinary ones; surface of the cysts marked by moderately coarse, interrupted striations. This species is the only one from this locality in which the cysts are not more or less interrupted by the rudimentary lamellæ."

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## STROMATOPORA, *Goldfuss.*

### SYRINGOSTROMA, *Nicholson.*

### STROMATOPORA (SYRINGOSTROMA) DENSUM.

*Plate* 10, *Fig.* 7.

*Syringostroma densa*, NICHOLSON. Pal. Ohio, vol. ii, p. 251, 1875.
*Agaricia boletiformis*, (Goldfuss), VAN CLEVE MSS., 1853.

The figure given, represents, in a measure, the characters described and illustrated in the original description of the species contained in vol. ii, of the Palæontology of Ohio, as follows:

"Sarcodeme apparently forming irregular masses or thick crusts, composed of an exceedingly dense calcareous tissue containing very minute cells. This tissue is probably essentially composed of successive concentric laminæ, separated by vertical dissepiments; but its density is so great that it may be regarded in practice as a mass of laminated calcareous matter in which excessively small but numerous cellular compartments are excavated. Not only are these cells extraordinarily small, but they are only now and then arranged in horizontal lines, and they often assume the form of minute tubuli passing through more than one layer. Hence it is impossible to count the number of laminæ or rows of cells in a given vertical space, and it can only be said that the mass is denser and the cells more minute than in any known species of stromatopora,

whilst, nevertheless, the composition of the whole out of concentric laminæ is very conspicuous. The mass is traversed by numerous very irregularly disposed horizontal canals which run nearly parallel with the surface, have a diameter of usually from one-fifth to one-fourth of a line, and are placed at intervals apart of from one-third of a line to about one line. The upper surface exhibits two distinct sets of apertures—*firstly*, a series of very minute and crowded perforations, which doubtless correspond with the cells of the mass; and, *secondly*, a larger set of apertures, which are very irregularly distributed, and are likewise very numerous. These latter apertures are circular, have a diameter of from one-eighth to one-fifth of a line, are placed at intervals of from one-fourth to one-half line apart, and are almost certainly the apertures of a series of vertical canals.

"As regards the additional characters of the surface, the specimens differ so materially that I can not with certainty affirm that they belong to the same species. In the most typical examples the surface is undulating, and exhibits numerous star-like, not elevated, impressions, formed of vermicular bifurcating horizontal canals, which radiate from a central point. When partially decorticated, it is seen that these radiating canals have a distinct calcareous lining, and, whilst in the main horizontal, some of them penetrate the mass obliquely, and thus pass below the actual surface. The diameter of these star-like impressions is about half an inch, or rather less; they are placed close together over the whole surface."

In the description given by Mr. Van Cleve he says: "The upper surface has confluent, irregularly scattered stars of unequal size." Taken in connection with his figure it seems evident that he had specimens of the species described by Professor Nicholson in the Palæontology of Ohio.

*Formation and Localities.*—Found in the Corniferous limestone in its extent through Ohio and Indiana.

# BRYOZOA.

## HUDSON RIVER GROUP.

### PTILODICTYA, *Lonsdale.*

#### PTILODICTYA FALCIFORMIS.

*Plate* 12, *Fig.* 1.

*Ptilodictya falciformis*, NICHOLSON. Pal. Ohio, vol. ii, p. 259. 1875.
*Ceriopora ensiformis*, VAN CLEVE MSS., 1853.

"Polyzoary consisting of a single unbranched, or slightly branched, elongated, flattened, narrow, and two-edged frond, the form of which is more or less curved and falciform, and which gradually expands from a pointed base till it reaches a width of two lines within a distance of less than half an inch above the base. The total length may exceed two inches, but the width rarely or never exceeds two and a half lines. The transverse section is acutely elliptical, the thickness in the middle not exceeding half a line, and the flat faces of the frond are very gently curved, and are not angulated. No central axis can, as a rule, be made out with certainty, though the existence of such can sometimes be demonstrated. The edges of the frond are thin and sharp, formed by a narrow band, which is longitudinally striated, and, when perfect, is perforated by the apertures of minute imperfect cells, which have a longitudinal direction. Both sides of the frond are celluliferous, the cells being apparently perpendicular to the surface, and being arranged in intersecting diagonal lines, which form angles of about thirty degrees with the sides of the frond, and thus cut one another at sixty degrees. The mouths of the cells are oval, or somewhat diamond-shaped, their long axis coinciding with the axis of the frond, alternately placed in contiguous rows, about eight in the space of one line measured diagonally, and ten in the same space measured transversely, the outermost rows very slightly smaller than the others. Walls of the cells moderately thick; no surface-granulations, tubercles, spines, or elevated lines. The mouths of the cells parallel with the general surface, neither lip being especially prominent, and the plane of the aperture not being oblique." (Nicholson, Pal. Ohio, vol. ii, p. 259. 1875.)

*Formation and Locality.*—Hudson River group in Ohio, and also found in the same horizon in Indiana.

## CLINTON GROUP.

### PTILODICTYA EXPANSA.

*Plate* 12, *Figs.* 2, 3.

*Phœnopora* (*Ptilodictya*) *expansa*, H. & W. Pal. Ohio, vol. ii, p. 114. 1875.
*Flustra lanceolata*, (Goldfuss) VAN CLEVE MSS., 1853.

"Frond forming broad, elongate stipes, the entire length and form not determined, the larger fragments seen measuring nearly an inch in width by nearly two and three-quarter inches in length, with a thickness of an eighth of an inch. The lateral edges are slightly irregular, but generally parallel in the specimens under consideration. Frond distinctly separated longitudinally into two parts by a thin, central partition, extending from edge to edge, from the surfaces of which the cells take their origin, and diverge obliquely upward and outward to the surface of the frond.

"Surface of the frond divided by thin, longitudinal partitions, forming the sides of the cells, and separating them into longitudinal rows. The outer edges of the partitions are slightly raised above the upper and lower walls of the cells, and count ten or eleven in the space of a tenth of an inch. Cells slightly oval, a little longer than wide, arranged in horizontal, or nearly horizontal rows, diverging from the central partition at an angle of about fifteen degress above a horizontal, but varying somewhat in different parts of the frond. There is an appearance of maculæ, or slightly elevated patches, on the surface, but they are not sufficiently distinct to determine their order or arrangement." (Hall & Whitfield. Pal. Ohio vol. ii, p. 114. 1875.)

Mr. Van Cleve evidently had very large and fine specimens of this and other species of bryozoans from the Clinton group of Dayton, Ohio. One of the illustrations shows the rounded and somewhat pointed termination of the fronds and their uniform width.

*Formation and Locality.*—In the yellow limestone of the Clinton group, near Dayton, Ohio. The term Clinton group for these limestones is used in deference to the Ohio Reports, and was also the position assigned to these rocks by Mr. Van Cleve. They may constitute a member of the Niagara group.

### PTILODICTYA [SUB GENUS?] BIPUNCTATA (*Van Cleve*), *N. Sp.*

*Plate* 13, *Fig.* 5.

*Eschara bipunctata*, VAN CLEVE MSS.

The following description is taken from the manuscript of Mr. Van Cleve, and, in connection with the figure, serves to

characterize this fine species in a very satisfactory manner. The lobate form of one of the fronds is not incompatible with the genus, and has been noticed in *P. falciformis*, Nicholson:

"*Eschara* spreading, leaf-like or lobed, flat; cells oval, in longitudinal ranges; end-borders of the cells bi-punctate.

"Thin, flat-spread, double membranes, of various forms, commencing with a narrow base and widening more or less, sometimes forming two lobes. The cells lie in longitudinal ranges, generally somewhat curved, running from the narrow base to the upper margin of the membrane, diverging frequently to make room for the intervention of new ranges as the fossil widens. The cell-mouths do not lie in regular ranges obliquely or crosswise, being in some places opposite to each other, and in others alternate. Two opposite dot-like cavities are formed in each space between the cells, as they succeed each other in the longitudinal ranges."

*Formation and Locality.*—In the limestone of the Clinton group, Dayton, Ohio.

## STICTOPORA, *Hall.*

### STICTOPORA COMPRESSA, *N. Sp.*

*Plate* 14, *Fig.* 3.

*Eschara compressa*, VAN CLEVE MSS., 1853.

"*Eschara* branching, compressed; branches broad, their edges without cells; cells oval, perpendicular.

"Compressed, broad, branching stems. The cells are larger and deeper than in any of the preceding species. They lie in longitudinal ranges, are oval, and are sunken perpendicularly to the surface of the stem. A portion of the thin edge of the stem is without cells."

*Formation and Locality.*—Clinton group, Dayton, Ohio.

### STICTOPORA BIFURCATA, *N. Sp.*

*Plate* 13, *Figs.* 3, 4.

*Eschara bifurcata*, VAN CLEVE MSS., 1853.

"*Eschara* forked, compressed, slightly channeled; branches slender; cells with oval mouths, in longitudinal ranges, and in oblique cross-ranges.

"Compressed slender forked twigs, which are slightly channeled lengthwise and have their cells in the channels. The cells are oval and very uniform in size and shape. A small cone is frequently seen in the bottom of a cell."

*Formation and Locality.*—Clinton group, Dayton, Ohio.

### STICTOPORA VANCLEVII, *N. Sp.*

*Plate* 13, *Figs.* 1, 2.

*Eschara ramosa*, VAN CLEVE MSS., 1853.
not *Stictopora ramosa*, HALL. Pal. N. Y., vol. i, 1847.

"*Eschara spreading, branching; branches in one plane, narrow; cells with oval mouths, imbricate, in oblique ranges.*"

"Thin, flat, narrow, branching stems, the numerous ramifications being all in one plane. The cells form longitudinal ranges, and lie over each other in oblique cross rows, their oval mouths diverging somewhat from the middle of each branch toward the edge."

*Formation and Locality.*—In the limestones of the Clinton group, at Dayton, Ohio.

### STICTOPORA MULTIFIDA, *N. Sp.*

*Plate* 14, *Fig.* 4.

*Eschara multifida*, VAN CLEVE MSS., 1853.

"*Eschara spreading, fan-shaped, divided into numerous, narrow, contiguous lobes; cells oval, imbricate, in oblique ranges.*"

"Thin, fan-shaped, flat-spread, double membranes, pedately cut into numerous divisions, which divide again and again, each branchlet, after every sub-division, having a breadth equal to that of its parent branch. The branches and their subdivisions each have about ten longitudinal ranges of cells, lying over each other in oblique cross ranges, and having slightly oval mouths."

This species somewhat resembles *S. magna*, Hall & Whitfield, from the same horizon, but has not the horizontal arrangement of the cell-pores, the microscopic pores at the base of each cell-aperture, and the branches are considerably smaller than in that species. The figure illustrates very well the size and manner of growth of this unusually fine species.

*Formation and Locality.*—In the yellow limestone of the Clinton group at Dayton, Ohio.

## RETEPORA, *Lamarck.*

### RETEPORA ANGULATA.

*Plate* 14, *Figs.* 1, 2.

*Retepora angulata*, HALL. Pal. N. Y., vol. ii, p. 49. 1852.
*Retepora producta*, VAN CLEVE MSS., 1853.

"Frond much expanded (perhaps cyathiform originally); branches anastomosing; fenestrules large, very oblong, oval or irregularly sub-rhomboidal, varying in size; non-poriferous face striated; poriferous face with two or three rows of pores on each branch; pores small, round, salient, papilliform." (Hall, Pal. N. Y., vol. ii, p. 49.)

The specimens which were described by Mr. Van Cleve showed that the entire form of the frond was cup-shaped or infundibuliform.

*Formation and Locality.*—Limestone of the Clinton group, Dayton, Ohio.

NOTE.—I have been requested by Dr. C. A. White to make some corrections in the references of figures to certain species of the Van Cleve corals, described by him in the Eleventh Report of the State Geologist of Indiana. The references and comments herewith communicated are not to be understood as made in any captious spirit, but as expressions of my own judgment regarding the proper relations of certain illustrations; which I submit with due deference to the opinions of others.

Those who were familiar with the labors of Mr. Van Cleve during his life time, know that one of his principal objects was the identification of the American Palæozoic corals with the figures and descriptions of Goldfuss; and this fact will, I think, offer a sufficient explanation for the statements I have made in the following paragraphs.

Plate 45, figs. 1, 2, page 393, *Amplexus yandelli.* Figs. 1 and 2 are not good representations of the species as known to us. *Zaphrentis rafinesqui*, figs. 3, 4, 5, represent different species; fig. 4 is apparently a Heliophyllum. Figs. 1, 2, 3 may represent *Zaphrentis undata*, page 291, plate 20, figs. 7 and 8; and plate 25, fig. 1, of this Report.

Plate 47, figs. 1, 2, page 396, *Fistulipora canadensis.* Fig. 1 has the circular apertures too regular and equidistant to represent *F. canadensis*, while the intermediate space does not show the angular apertures, which are so conspicuous in that species. (See Rominger, Fossil Corals, Plate VIII.) The figure 1 represents a species of Syringopora, apparently *S. tabulata.* Fig. 2 is probably a representation of *Favosites venustus.*

Plate 47, figs. 3, 4, page 399, *Syringopora Maclurei.* The corallites are too small and too closely arranged to represent this species as usually known. The figure has a nearer resemblance to *S. perelegans*, but is less diffuse. *Compare Syringopora reticulata*, Goldfuss, XXV, fig. 8.

Plate 47, fig. 7, is much larger than the ordinary forms of *Striatopora Linnæana*, and may represent another form of the genus. The figure appears to me to have been in part derived from fig. 5, plate XXVII, of the Petrefacta Germania, which the author describes under *Calamopora polymorpha*, "var. *gracilis, ramis gracilibus elongatis.*"

Plate 48, fig. 1, probably represents *Diphyphyllum arundinaceum*, with some modifications in the illustration intended to conform the expression to the species of Goldfuss, with which it had been identified by the author.

Plate 49, fig. 1, page 390, represents *Eridophyllum Verneuilianum*.

Plate 49, fig. 3, page 398, *Syringopora perelegans*. This figure does not represent *S. perelegans*. In size, the corallites approach those of *S. maclurei*, but they are too compactly arranged, and in this respect, as well as in size, more nearly represent certain conditions of S. verticillata of the Niagara group.

Plate 50, fig. 1, page 387. This illustration is undoubtedly intended to represent *Diphyphyllum Archiaci*, but has been made to conform in some degree to the figure of *Cyathophyllum cæspitosum* of Goldfuss, and presents the corallites in too close proximity.

Plate 50, fig. 2, page 395, *Favosites polymorpha*. The figure is evidently copied, in a reversed position, from fig. 3a, plate XXVII of Goldfuss' Petrefacta, and is the "*var. tuberoso ramosa, tubis minoribus graculibus*" of Goldfuss. It is not unlike some varieties of form of the *F. hemispherica*, which is a very polymorphous species and, perhaps, the nearest representative which we have to the European *F. polymorpha*.

Plate 51, fig. 1, page 389, *Diphyphyllum arundinaceum*. The figure does not represent any ordinary form of this species, and it may well be doubted if it represents any American Devonian coral. The figure was apparently intended by Mr. Van Cleve as a representation of *Lithodendron cæspitosum* of Goldfuss, which is cited by him as occurring at Bensburg, Germany, and Dayton, Ohio.

Plate 51, figs. 2, 3, 4, page 376, "*Streptelasma corniculum*." Figs. 2 and 3 represent *Zaphrentis canadensis*, Billings.

Plate 52, figs. 1, 2, page 383. Fig. 1 apparently represents *Favosites epidermatus*, Rominger. Fig. 2 may be of that species, or of some other form from the Corniferous limestone.

Plate 53, figs. 1, 2. page 395. Fig. 1 is evidently copied from fig. 2a, plate XXVII of Goldfuss' Petrefacta, and is the variety of Calamopora polymorpha designated by that author as "*var. tuberosa, tubis maioribus et elongatis*." The American form most nearly allied to this may be found among the varieties of *F. hemispherica*. Fig. 2 is copied from the same author, fig. 3, plate XXVII, and is arranged by him under "*var. tuberosa-ramosa, tubis minoribus gracilibus*." This figure would compare very well with forms of *F. hemispherica* known in Ohio and Indiana. Plate 53, fig. 3, page 396, *Favosites polymorpha, var. dubia*. This figure of Mr. Van Cleve is evidently copied, with modifications, from the figure 4a, plate XXVII, of Goldfuss. The lower part of the original has been left out. This form is placed by Goldfuss under *Calamopora polymorpha*, "*var. ramosa-divaricata tubis obeonicus*," and with fig. 4b of the same plate, has much resemblance to some of our branching forms of Favosites.

Plate 54, fig. 1, page 394. The figure of Mr. Van Cleve is evidently copied from plate XXVII, fig. 1a of Goldfuss' Petrefacta, and is the *Calamopora infundibulifera* of that author. The figure closely resembles some forms of *Favosites tuberosa*, Rominger, from the Corniferous limestone of the West.

Plate 54, figs. 2, 3, pages 396 and 397. These figures represent the upper and lower sides of *Alveolites Goldfussi*.

Plate 55, figs. 1, 2, page 391, *Cystiphyllum vesiculosum*, does not represent that species, and is apparently closely allied to *Cystiphyllum infundibulum*, and *C. crateriforme*, Hall, Fossil Corals of the Upper Helderberg group, pages 57 and 58, 1882.

# DESCRIPTIONS

OF

# FOSSIL CORALS FROM THE NIAGARA AND UPPER HELDERBERG GROUPS OF INDIANA.

BY PROFESSOR JAMES HALL.

The limestones of the Niagara and Upper Helderberg Groups, in Southern Indiana, the falls of the Ohio, and adjacent portions of Kentucky, have proved extremely prolific in numerous forms of fossil corals. Some of these forms were described by Rafinesque and Clifford, and by Lesueur, as early as 1820; others were described by Troost from 1840 to 1844. A considerable number of species from this region were described by Edwards and Haime in 1851, and these constitute an interesting and important feature in their "*Descriptions des Polypiers Fossile des Terrains Palæzoique.*" More recently (1876) Dr. Rominger has added considerably to the number of described species from this region, and there still remains much to be done before we shall be able to present a complete history of this class of fossils from the Palæozoic rocks of Indiana.

The following described species, most of them of new forms, have been obtained from the following sources, viz.: From the collections made by myself and assistants during several years; from specimens received from Dr. James Knapp and Henry Nettelroth, Esq., of Louisville; by the purchase of an extensive collection from Rev. H. Herzer, embracing specimens from Ohio, Indiana and Kentucky, and finally from collections placed in my hands by the State Geologist of Indiana.

# CORALS OF THE NIAGARA GROUP.

## Genus CHONOPHYLLUM, *Edwards & Haime.*

### CHONOPHYLLUM VADUM.

*Plate* 15, *Figs.* 1–4.

*Chonophyllum vadum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 6. August, 1882.

Corallum simple, turbinate, straight or slightly curved, acute at the base, regularly expanding to the calyx; exterior with numerous abrupt constrictions and fine concentric striæ; external costæ very distinct; height thirty-five millimeters; diameter of calyx, twenty millimeters; depth ten millimeters; sides slightly concave; a flat space at the bottom five millimeters in diameter; number of lamellæ seventy, flat and of nearly uniform size at the margin, becoming thinner and alternating in size below; the principal ones extending to the center, where they are twisted and very slightly elevated.

*Formation and Locality.*—Niagara group, Louisville, Kentucky.

## Genus ANISOPHYLLUM, *Edwards & Haime.*

### ANISOPHYLLUM UNILARGUM.

*Plate* 15, *Figs.* 5, 6.

*Anisophyllum unilargum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 8. August, 1882.

Corallum simple, turbinate, slender, acute at the base, regularly expanding to the calyx; height thirty millimeters; diameter of calyx twelve millimeters; depth ten millimeters; number of lamellæ fifty, alternating in size, smaller ones rudimentary; commencing at the center and continuing to the anterior margin is an excessively developed lamellæ, which is prominent at the center, becoming less as it approaches the margin, and at nearly right angles to it are two narrow fossettes; the two lamellæ anterior to the fossettes are somewhat more prominent than the others.

*Formation and Locality.*—Niagara group, Louisville, Kentucky.

### ANISOPHYLLUM TRIFURCATUM.

*Plate* 15, *Figs.* 7, 8.

*Anisophyllum trifurcatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 9. August, 1882.

Corallum simple, elongate turbinate, slender, very gradually enlarging; exterior with numerous concentric wrinkles and striations; height twenty millimeters; diameter of calyx eight millimeters; depth five millimeters; number of lamellæ fifty-four; three of the lamellæ more prominent than the others, one of which is situated anteriorly, the other two laterally, the remainder alternate in size, the smaller ones extending but a short distance from the margin; some of the lamellæ converge to the three prominent ones, the others to the center of the calyx.

This species may be distinguished from *A. unilargum* by its somewhat more slender form, its thinner lamellæ and the absence of lateral fossettes. The prominent lamellæ are not excessively developed.

*Formation and Locality.*—Niagara group, Louisville, Ky.

## CYATHOPHYLLUM, *Goldfuss.*

### CYATHOPHYLLUM INTERTRIUM.

*Plate* 15, *Figs.* 9–11.

*Cyathophyllum intertrium*, HALL. Thirty-fifth Annual Report of the N. Y. State Museum of Natural History, advance sheets, page 12. August 1882.

Corallum simple, broadly turbinate, base obtuse, regularly expanding to the calyx; external costæ very distinct; exterior with frequent slender processes, which served for attachment and support; height of corallum fifteen millimeters; diameter of the base seven millimeters; diameter of calyx, eighteen millimeters; depth five millimeters; regularly concave, a space at the bottom flat or slightly curved; tabulæ broad, extending the entire diameter of the corallum. There are thirty prominent thin lamellæ, and between each two of these are three smaller lamellæ; the large ones extend to within from three to five millimeters of the center, leaving a smooth space from six to ten millimeters in diameter.

*Formation and Locality.*—Niagara group, Louisville, Ky.

## CYSTIPHYLLUM, *Lonsdale.*

### CYSTIPHYLLUM GRANILINEATUM.

*Plate* 15, *Fig.* 13, *and Plate* 23, *Fig.* 13.

*Cystiphyllum granilineatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 14. August, 1882.

Corallum simple, turbinate, straight or slightly curved, acute at the base, regularly and rapidly expanding to the calyx; exterior with concentric wrinkles and numerous fine but distinct concentric striæ, thirty-five in the space of five millimeters; external striæ very distinct; there are frequent slender processes, serving for attachment and support; when decorticated the cysts are conspicuous; height of corallum twenty-five millimeters; diameter of calyx twenty-five millimeters; depth fifteen millimeters; cysts prominent, varying from one to two millimeters in diameter, covered by rudimentary lamellæ, 120 in number, uniform in size, exterding to within two millimeters of the center, and very finely granulated.

This species has a close general resemblance to some of the shorter forms of *C. Niagarense*, but the lamellæ and denticulations are much finer.

*Formation and Locality.*—Niagara group; Louisville, Kentucky.

## HELIOPHYLLUM, *Hall.*

### HELIOPHYLLUM PRAVUM.

*Plate* 15, *Fig.* 12, *and Plate* 25, *Fig.* 4.

*Heliophyllum pravum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 13, 1882,

Corrallum simple, elongate turbinate, curved or tortuous, acute at the base, with frequent constrictions above, not regularly expanding to the calyx; exterior with numerous narrow angular annulations; height of corallum twenty-five millimeters; diameter of calyx ten millimeters; depth five millimeters; some individuals have a greater proportional diameter; calyx campanulate, a flat space five millimeters in diameter at the bottom; fossette dextral, moderately conspicuous at the bottom, becoming obsolete before reaching the margin; number of lamel-

læ fifty, of uniform thickness, alternating in length, rounded at the margin, becoming very thin as they approach the center; the shorter lamellæ continue to the flattened space at the bottom of the calyx, the others to within a short distance of the center, leaving a well defined concave space of two millimeters in length and one millimeter in width, in continuation of the fossette; denticulations thin, prominent, eleven in the space of five millimeters.

*Formation and Locality.*—Niagara group, Louisville, Ky.

## CYATHAXONIA, *Michelin.*

### CYATHAXONIA HERZERI.

*Plate* 15, *Fig.* 14.

*Cyathaxonia Herzeri*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 12. August, 1882.

Corallum simple, turbinate, straight or slightly curved, acute at the base, regularly expanding to the calyx; height forty-five millimeters; calyx oblique; diameter thirty millimeters; length of anterior side of corallum fifteen millimeters; columella conical, seven millimeters in height; number of lamellæ about one hundred, alternating in size, the smaller ones about one-third the thickness of the others, which continue to the columella.

*Formation and Locality.*—Niagara group, Louisville, Ky.

## CORALS OF THE UPPER HELDERBERG GROUP.

## STREPTELASMA, *Hall.*

### STREPTELASMA COARCTATUM.

*Plate* 15, *Figs.* 15, 16.

*Streptelasma coarctatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 21. August, 1882.

Corallum simple, turbinate, curved, usually slightly compressed; exterior with broad undulations; height fifty millimeters; calyx slightly oval, greatest diameter twenty-five millimeters; depth twenty millimeters, sides regularly sloping to the

center, an elevation at the bottom five millimeters in height; fossette obscure or wanting; number of lamellæ eighty, near the margin of uniform size, thickened and rounded, on the sides alternating, becoming thin as they approach the center; the principal ones continue to the center, twisting and coalescing. The elevation at the center might be considered as due to tabulæ, but there is no evidence of their existence in the specimens examined.

*Formation and Locality.*—Corniferous limestone, Louisville, Kentucky.

### STREPTELASMA INFLATUM.

*Plate* 15, *Figs.* 17, 18.

*Streptelasma inflatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 18. August, 1882.

Corallum simple, turbinate, straight or slightly curved, very attenuate below; exterior with gentle undulations and with strong longitudinal striæ; height forty millimeters; for about one-half the height gradually, then very abruptly expanding; diameter of calyx forty millimeters, depth twenty-five millimeters; fossette deep, commencing at the center, five millimeters in width, seven millimeters in length, situated on the posterior side; number of lamellæ eighty, alternating in size, rounded at the margin, becoming sharp on the sides. The adjacent principal lamellæ of the anterior portion of the calyx coalesce as they approach the center, these again coalesce, forming fascicles of from two to seven lamellæ; those of the anterior portion are not fasciculated.

This species bears some resemblance to the figure of *Zaphrentis corticata*, but the lamellæ are coarser; their arrangement at the center is different, and the external characters are very dissimilar to those of that species.

*Formation and Locality.* Corniferous limestone, Falls of the Ohio.

### STREPTELASMA PAPILLATUM.

*Plate* 15, *Fig.* 20.

*Streptelasma papillatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History. Advance sheets, p. 21. August, 1882.

Corallum simple, turbinate, curved; exterior with gentle un-

dulations and a few sharp annulations; height of corallum fifty millimeters; diameter of calyx thirty-five millimeters; depth twenty-five millimeters; sides abruptly descending, leaving a flat or concave space at the bottom, fifteen millimeters in diameter, in the center of which is a conical elevation of five millimeters in height; number of lamellæ eighty, at the margin of nearly uniform size, alternating below, the principal lamellæ extending to the center, twisted and elevated, forming a very much contorted false columella.

This species most closely resembles *S. mammiferum*, but is less abruptly expanded. The calyx is circular, not oblique; the lamellæ are smaller, there being eight or nine in the space occupied by six in that species; the elevation on the bottom of the calyx is less prominent and somewhat different in character.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### STREPTELASMA SIMPLEX.

*Plate* 16, *Fig.* 1.

*Streptelasma simplex*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 18. August, 1882.

Corallum simple, turbinate, straight or slightly curved; exterior with concentric wrinkles and striæ; longitudinal striæ distinct; height of corallum thirty millimeters; depth of calyx twenty millimeters; sides regularly sloping; fossette situated a little on one side of the center, and consisting of a deep depression not extending on the sides of the calyx; number of lamellæ sixty; at the margin broad, rounded, nearly uniform in size, alternating below; the principal lamellæ extending to the center are twisted and elevated, forming a small false columella. In all the individuals observed there are no tabulæ.

One specimen having a height of nearly forty millimeters, and a diameter at the calyx of thirty-five millimeters, corresponds essentially with this species, except that on one side of the calyx is a smooth elevation extending from the center to the margin, acute at the center and expanding as it recedes, being at the margin three millimeters wide, but this feature is probably due to accident.

*Formation and Locality.*—Corniferous limestone; Falls of the Ohio.

### STREPTELASMA MAMMIFERUM.

*Plate* 16, *Figs.* 2, 3, *and Plate* 21, *Figs.* 1, 2.

*Streptelasma mammiferum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 21. August, 1882.

Corallum simple, turbinate, attenuate below, expanded on the anterior, flattened on the posterior side; exterior with annulations and gentle undulations; longitudinal striæ coarse, distinct; height sixty millimeters; calyx oval, length forty-five millimeters; width thirty millimeters; sides abruptly sloping, a conical elevation at the bottom ten millimeters in height; number of lamellæ seventy, alternating in size (in some individuals this feature is much more strongly marked than in others); near the margin the lamellæ are broad, rounded, becoming very thin as they approach the center, where they are twisted and coalescing, forming a prominent false columella, with prolonged tip.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### STREPTELASMA TENUE.

*Streptelasma tenue*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 17. August, 1882.

Corallum small, turbinate or sub-cylindrical, regularly curved or tortuous; surface with numerous annulations; longitudinal striæ very distinct; height about thirty-five millimeters; diameter of calyx from ten to fifteen millimeters; depth from fifteen to twenty millimeters; number of lamellæ fifty, alternating in size, the larger ones extending nearly or quite to the center.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## PTYCHOPHYLLUM, *Edwards & Haime.*

### PTYCHOPHYLLUM KNAPPI.

*Plate* 18, *Figs.* 14, 15, *and Plate* 25, *Figs.* 6, 7.

*Ptychophyllum versiforme*, in part HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 22. August, 1882.

Corallum simple, turbinate, curved, sometimes tortuous, rapidly expanding; frequently intermittent and proliferous in its mode of growth; length usually from forty to sixty millimeters;

calyx from forty to seventy millimeters in diameter; exterior with frequent sharp annulations and concentric striæ; the calyx for some distance from the margin is flat, then abruptly descending, having a depth of from fifteen to twenty millimeters; center of calyx elevated; number of lamellæ from 90 to 100, slightly alternating in size, near the margin broad and nearly flat, becoming sharper as they approach the center; the stronger lamellæ continue to the center, are twisted and elevated, forming a false columella.

*Formation and Locality.*—Crab Orchard, Kentucky.

## AULACOPHYLLUM, *Edwards & Haime.*

### AULACOPHYLLUM TRISULCATUM.

*Plate* 16, *Fig.* 5.

*Aulacophyllum trisulcatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 25. August, 1882.

Corallum turbinate, irregularly expanding, exterior with numerous constrictions caused by intermittent growth; internal costæ sharp, prominent; height of corallum forty millimeters; calyx thirty-five millimeters in diameter, sub-quadrangular in outline; depth twenty millimeters, sides abruptly sloping to the center. There are three fossettes, one wide and deep, extending from the center of the calyx to the anterior margin; the others not so strong, but conspicuous, are situated at right angles to the principal one; lamellæ about 112, alternate ones much larger than the others, very sharp and prominent, converging to the fossettes, and on the posterior side to a line in continuation of the principal fossette; a few lamellæ reach the center of the calyx.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio, and Clark county, Indiana.

### AULACOPHYLLUM SULCATUM.

*Plate* 17, *Figs.* 7–10.

*Caninia sulcata*, D'ORBIGNY. Prodr. de Palæont. Univ., xi, p. 105. 1850.

*Aulacophyllum sulcatum*, EDWARDS & HAIME. *Polypiers Fossiles des Terrains Palæozoique*, p. 355. Plate 6, fig. 2.

Corallum simple, turbinate, regularly curved; calyx oblique;

in some examples the length on the anterior side is 120 millimeters or more, but usually the specimens are smaller, the length of the anterior side being seventy millimeters, and the posterior side twenty-five millimeters; calyx oval or sub-rhomboidal; length fifty millimeters, width forty millimeters; in none of the numerous specimens observed is the calyx perfect, and its depth can not be exactly known, but it was probably shallow; the specimens are usually decorticated and somewhat smooth; internal costæ very prominent, converging to a line along the middle of the anterior side, and less distinctly to a line on the posterior side; the costæ of the posterior side also converge to the dextral and sinistral sides; fossette commencing near the center and continuing to the anterior margin; an obscure fossette extends from the center to the posterior margin; number of lamellæ 160, alternating in size, the smaller ones extend a very short distance from the margin; part of the anterior lamellæ converge to the fossette, the others converge to two lamellæ at right angles to the principal fossette, the greater portion of the lamellæ of the posterior side also converge to these two lamellæ, a few converge to the indistinct posterior fossette; the convergence of the lamellæ on the dextral and sinistral sides gives the appearance of lateral fossettes. The two lamellæ to which the others converge frequently coalesce and extend entirely across the calyx.

*Formation and Locality.* Corniferous limestone, falls of the Ohio, and Clark county, Indiana.

### AULACOPHYLLUM PRÆCIPTUM.

*Plate* 16, *Figs.* 6, 7.

*Aulacophyllum præciptum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 24. August, 1882.

Corallum simple, turbinate, straight or slightly curved; exterior with strong annulations, concentric wrinkles and fine striæ; longitudinal striæ fine, distinct; height of corallum fifty millimeters; diameter of calyx forty millimeters; depth thirty millimeters; sides regularly sloping to the center, the calyx having the form of an inverted cone; principal fossette narrow, extending from the center nearly to the margin; number of lamellæ 120, of nearly uniform size at the margin, alternating

below. There are two rudimentary fossettes at right angles to the principal one; the lamellæ of the anterior side converge to the principal fossette, a few converge to the rudimentary fossettes, the remaining larger lamellæ continue to the center of the calyx.

*Formation and Localities.*—Corniferous limestone; Falls of the Ohio and Clark county, Indiana.

### AULACOPHYLLUM PRINCEPS.

*Plate* 16, *Figs.* 8, 9, 10.

*Aulacophyllum princeps*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 23. August, 1882.

Corallum simple, turbinate, regularly curved; exterior with numerous irregular undulations of growth, concentric wrinkles and striations; longitudinal striæ fine and very distinct; height of full-grown specimens from seventy to one hundred millimeters; diameter of calyx from forty to fifty millimeters; depth thirty millimeters; form sometimes oval or sub-quadrangular; sides abruptly descending, leaving a broad flat or elevated space at the bottom; fossette commencing anteriorly to the center, not continuing to the margin; number of lamellæ from 160 to 180, of nearly uniform size at the margin; on the sides the alternate lamellæ are much larger than the others; about two-thirds of the lamellæ converge to the fossette, or to a line in continuation of it; the remainder converge toward the center of the calyx; near the center the lamellæ are thickened and twisted. From *A. sulcatum* this species is easily distinguished by the more numerous and thinner lamellæ.

*Formation and Localities.*—Corniferous limestone, New York, and Falls of the Ohio.

### AULACOPHYLLUM CONVERGENS.

*Plate* 17, *Figs.* 1, 2.

*Aulacophyllum convergens*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 22. August, 1882.

Corallum simple, broadly sub-turbinate, regularly curved; exterior comparatively smooth with concentric wrinkles and striations; longitudinal striæ fine, distinct; specimens of the same height have a diameter at the calyx varying from twenty-

five to forty-five millimeters; in one example the height is ten millimeters; length of posterior side, twelve millimeters; of anterior side, twenty-five millimeters; diameter of calyx, twenty millimeters, for a distance of five millimeters, from the margin nearly flat, then the posterior portion is nearly vertical, the anterior portion concave; fossette narrow, deep, extending from the bottom of the calyx to the anterior margin; lamellæ varying from 80 to 120 in number according to the diameter of the calyx, alternating in size, thin, denticulated; convergence of the lamellæ to the fossette very distinct.

*Formation and Localities.* Corniferous limestone, Falls of the Ohio, and Clark county, Indiana.

### AULACOPHYLLUM PRATERIFORME.

*Plate* 17, *Figs.* 3, 4.

*Aulacophyllum prateriforme*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 23. August, 1882.

Corallum simple, turbinate, curved; exterior with concentric wrinkles and striations and occasional constrictions; height of corallum thirty millimeters; length of anterior side fifty millimeters; length of posterior side thirty-five millimeters; diameter of calyx forty-five millimeters; depth twenty millimeters; regularly concave, bottom of the calyx a little posterior to the center; fossette narrow extending from the center to the anterior margin; number of lamellæ 110, alternating in size; about sixteen of the larger lamellæ converge to the fossette, the others continue to the bottom of the calyx, where they are slightly twisted, not elevated.

In general appearance this species is similar to *A. convergens*, but the anterior and posterior sides are more nearly equal in length, the deepest part of the calyx is nearly central, while in that species it is posterior; the converging of the lamellæ to the fossettes is much less distinct.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### AULACOPHYLLUM CRUCIFORME.

*Plate* 17, *Figs.* 5, 6.

*Aulacophyllum cruciforme*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 24. August, 1882.

Corallum simple, turbinate, regularly curved; length of posterior side twenty-five millimeters; length of anterior side sixty millimeters; calyx oblique, slightly oval; length forty millimeters; width thirty-five millimeters, regularly concave; fossette commencing just anterior to the center, and for the space of ten millimeters very deep and pyriform, narrowing and continuing to the anterior margin; number of lamellæ 140; nearly uniform in size at the margin, alternating below; the larger lamellæ, except those which converge to the fossette, continue to within eight millimeters of the center of the calyx, leaving a convex space sixteen millimeters in diameter, nearly smooth; at the junction of the posterior and anterior lamellæ are two rudimentary fossettes at right angles to the principal fossette.

This species is distinguised from *A. princeps* by the conspicuous pyriform fossette, the smooth space at the bottom of the calyx, and the more conspicuous lateral fossettes.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### AULACOPHYLLUM POCULUM.

*Plate* 18, *Figs.* 2, 3, 4.

*Aulacophyllum poculum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 25 August, 1882.

Corallum simple, sub-cylindrical, short; the attached portion of the base large, frequently equal to the diameter of the corallum; height of the corallum twenty millimeters; diameter of calyx twenty millimeters; depth from eight to twelve millimeters; sides sloping abruptly, leaving at the bottom a concave space three millimeters wide; fossette situated posteriorly, extending from the concave space at the bottom of the calyx to the margin; number of lamellæ from eighty to ninety, alternating in size, the smaller ones scarcely more than rudimentary.

The lamellæ near the fossette converge to it, the others converge to the center; a few extend upon the concave tabulæ and coalesce with it.

*Formation and Locality.* Corniferous limestone, Falls of the Ohio.

### AULACOPHYLLUM REFLEXUM.

*Plate* 18, *Figs.* 5, 6, 7.

*Aulacophyllum reflexum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 24. August, 1882.

Corallum simple, elongate, turbinate; exterior comparatively smooth; height forty millimeters; diameter of the calyx from twenty to twenty-five millimeters; depth fifteen millimeters; sides nearly vertical; fossette conspicuous, extending from the center to the margin; number of lamellæ eighty, alternating in size, the smaller ones about one-third the thickness of the others, and extending but a short distance from the margin, a portion of the larger lamellæ converge to the fossette, and their extremities on the side of the fossette are turned backward; the lamellæ opposite the fossette extend beyond the center to the bottom of the fossette; the remaining lamellæ do not reach the center of the calyx, their extremities forming a line at right angles to the fossette. There are two rudimentary fossettes.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### AULACOPHYLLUM PINNATUM.

*Plate* 18, *Fig.* 1, *and Plate* 22, *Fig.* 10.

*Aulacophyllum pinnatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 23. August, 1882.

Corallum simple, turbinate, exterior with undulations of growth; longitudinal striations distinct; height thirty-five millimeters; diameter of calyx thirty millimeters; depth twenty-five millimeters; sides regularly sloping; a narrow deep fossette extends from the bottom to the anterior margin; number of lamellæ from eighty to ninety, alternating in size, the larger ones only reaching the fossette and the bottom of cup, thickened and subangular near the margin, becoming

thinner on the sides; convergence of the lamellæ to the fossette very distinct; there are two rudimentary lateral fossettes, and a less conspicuous one on the posterior side.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### AULACOPHYLLUM TRIPINNATUM.

*Plate* 22, *Figs.* 8, 9.

*Aulacophyllum tripinnatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 25. August, 1882.

Corallum simple, turbinate, short, some individuals expanding gradually and others rapidly; diameter of calyx twenty millimeters; number of lamellæ eighty, alternate ones much the larger; their arrangement is as follows: On the posterior side one lamellæ extends from the margin to the bottom of the cup, a little on one side of the center; those adjacent on the left converge to it, those on the right are parallel with it; on the right side is a deep fossette, on the left side is a less conspicuous fossette, a sharp depression connecting the two; the lamellæ converge to the fossettes and the connecting depression, not reaching the center of the calyx; anterior to the depression is an oblique space ten millimeters wide, and about the same height, essentially smooth, formed by the coalescing of the lamellæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## ZAPHRENTIS, *Rafinesque.*

### ZAPHRENTIS TORTA.

*Plate* 22, *Fig.* 1.

*Zaphrentis torta*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 30. August, 1882.

Corallum simple, elongate turbinate, straight or slightly curved; exterior with concentric wrinkles and striæ, and occasional sharp annulations, longitudinal striæ distinct; height of corallum sixty millimeters; diameter of calyx thirty millimeters; depth twenty-five millimeters; sides abrupt. The tabulæ, for a space of five millimeters are nearly flat, then elevated

about five millimeters for a short distance, and then curving downwards; number of lamellæ seventy-five, alternating in size, the smaller ones about one-half the thickness of the others; the principal lamellæ extend to the center of the tabulæ, fasciculating and very much twisted; the sides of the lamellæ have moderately strong longitudinal striations; fossette extending from the center of the calyx to the margin; its position variable.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio, and Clark county, Indiana.

### ZAPHRENTIS SUBCOMPRESSA.

*Plate* 18, *Figs.* 8, 9.

*Zaphrentis subcompressa*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 28. August, 1882.

Corallum simple, turbinate, curved, somewhat flattened, exterior with numerous sharp annulations of growth; height of corallum, forty millimeters; calyx thirty millimeters in diameter, broadly oval; depth fifteen millimeters; sides abruptly descending; a slightly convex area at the bottom fifteen millimeters in diameter; fossette commencing near the center and extending about half way to the anterior margin; lamellæ about sixty; nearly uniform in size at the margin; thickened and subangular on the sides, becoming thinner and alternating; the principal lamellæ extend to within four millimeters of the center, becoming much thickened for the last three millimeters; the central portion of the calyx consists of a smooth, flat space eight millimeters in diameter.

This species somewhat resembles *Z. corrugata*, but the lamellæ are much thicker at the margin of the cup, and more nearly uniform in size; the central portion of the calyx is smooth, and the lamellæ are much thickened as they approach this area.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS FOLIATA.

*Plate* 18, *Figs.* 10, 11.

*Zaphrentis foliata*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 34. August, 1882.

Corallum simple, elongate, turbinate, curved; surface with fre-

quent narrow undulations and occasional constrictions; external striations distinct; height of corrallum seventy millimeters; diameter of calyx, twenty-five millimeters, depth, twenty millimeters; lamellæ about seventy, nearly uniform in size and thickened at the margin, alternating and thin below; the principal lamellæ fasciculate and extend to within a short distance of the center, leaving a smooth concave space three millimeters in diameter.

In a transverse section the corallum appears as if composed of numerous thin invaginated laminæ; in that respect it resembles *Cyathophyllum exfoliatum*, but that species is much stronger and coarser in appearance.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS PROFUNDA.

*Plate* 19, *Fig.* 1.

*Zaphrentis profunda*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 31. August, 1882.

Corallum simple, elongate turbinate, curved; exterior with numerous annulations; external striæ fine, distinct; height of corallum seventy millimeters; diameter of calyx twenty-five to thirty-five millimeters; depth twenty-five to forty millimeters; there is usually a flat space at the bottom of the calyx from one-half to three-fourths the diameter of the corallum at that point, but this feature is sometimes obsolete; number of lamellæ from one hundred to one hundred and ten, alternating in size, thicknened at the margin, thin and sharp below; the principal lamellæ extend to within five millimeters of the center, coalescing with the tabulæ, and leaving a smooth, nearly flat space of ten millimeters in diameter. The proportion of length and diameter is variable; individuals with calices of the same diameter vary in length from 35 to 80 millimeters.

*Formation and Locality.*—Corniferous limestone; falls of the Ohio.

### ZAPHRENTIS ELEGANS.

*Plate* 19, *Figs.* 2–5.

*Zaphrentis elegans*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 37. August, 1882.

Corallum simple, turbinate, usually slightly compressed, acute at the base, regularly expanding to the calyx; exterior with concentric wrinkles and undulations, external striæ distinct, fourteen in the space of ten millimeters; when decorticated the internal striæ are usually broad, equal to one-half the number of the lamellæ; corallum usually about seventy millimeters in height; diameter of calyx thirty millimeters; depth twenty millimeters, sides abrupt, an oval space at the bottom smooth or with the lamellæ faintly indicated; fossette usually dextral, consisting of a deep elongate depression at the bottom of the cup, but faintly indicated on the sides; number of lamellæ from eighty to ninety, alternating in size, thickened and sub-angular at the margin, becoming very thin and fragile below.

This species may be distinguished from *Z. profunda* by its compressed form, shallower calyx and finer lamellæ; from *Z. nitida* it differs in its compressed form, narrower flattened space at the bottom of the calyx, and somewhat finer lamellæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS PONDEROSA.

*Plate* 19, *Fig.* 7.

*Zaphrentis ponderosa*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History. Advance sheets, p. 27. August, 1882.

Corallum simple, turbinate, curved and oblique; exterior with strong rounded ridges, longitudinal striations obscure; height of corallum, one hundred millimeters; diameter of calyx, forty-five millimeters; depth thirty-five millimeters, with a rounded elevation of fifteen millimeters in diameter at the bottom; number of lamellæ ninety, nearly uniform in size, thickened and rounded at the margin, alternating below, and becoming thin and sharp as they approach the center. A portion of the lamellæ extend to the center, twisting and coalescing with the elevated portion of the tabulæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS NITIDA.

*Plate* 19, *Figs.* 6, *and Plate* 20, *Figs.* 4–6.

*Zaphrentis nitida*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 31. August, 1882.

Corallum simple, elongate-turbinate, straight or slightly

curved; exterior with numerous sharp annulations and constrictions caused by intermittent growth; external striæ, very distinct; height of corallum eighty millimeters; diameter of calyx thirty-five millimeters; depth twenty millimeters; somewhat campanulate; a space at the bottom from ten to fifteen millimeters in diameter smooth, nearly flat; fossette consisting of a deep pit, its continuation extending on the side, but becoming obsolete before reaching the margin of the calyx; number of lamellæ, from seventy-five to ninety; nearly uniform in size; thickened and rounded at the margin, becoming thin and alternating below; the principal lamellæ extend a short distance on the tabulæ, coalescing with them, not twisted.

This species most nearly resembles *Z. profunda*, but is a more solid form, and the calyx is not so deep.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS, SPISSA.

*Plate* 19, *Figs.* 8, 9.

*Zaphrentis Spissa*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 30. August, 1882.

Corallum simple, abruptly turbinate, straight or slightly curved; height of corallum seventy millimeters; diameter of calyx fifty millimeters; sides regularly concave; number of lamellæ 110, of uniform thickness, alternating in length, the principal ones extending to the center, fasciculating, coalescing and twisting; presenting a very irregular appearance; fossette conspicuous, commencing a short distance from the center and extending to the anterior margin.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS TRISUTURA.

*Plate* 20, *Figs.* 1–3.

*Zaphrentis trisutura*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 30. August, 1882.

Corallum simple, turbinate, quadrilateral, straight or slightly curved; longitudinal striæ conspicuous; height fifty millimeters; diameter of calyx thirty-five millimeters; sides nearly vertical or slightly convex, space at the bottom twenty-five

millimeters in diameter; fossette consisting of a deep depression at the sinistral margin of the tabulæ; number of lamellæ seventy, alternating in size, very thin and sharp on the sides of the cup, adjacent lamellæ coalescing and fasciculating, the lamellæ thus formed again fasciculate and extend to the center, where they are twisted and elevated into a comparatively sharp crest.

The quadrilateral form, convex tabulæ, deep fossette, and fasciculated lamellæ are characteristics by which this species may be easily distinguished.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS DEFORMIS.

*Plate* 20, *Figs.* 9, 10.

*Zaphrentis deformis*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History.

Corallum simple, sub-cylindrical, small, the attached portion broad, expanding only on one side of the apex, giving to the corallum a very oblique growth; diameter essentially uniform throughout the whole length; exterior with numerous oblique wrinkles and annulations; longitudinal striations somewhat obscure; when decorticated, the internal striæ are broad and smooth, seven in the space of ten millimeters; height of corallum thirty-five millimeters; diameter of calyx fifteen millimeters; number of lamellæ twenty-five to thirty, uniform in size, extending nearly to the center, leaving a smooth flat space five millimeters in diameter.

The great expansion on one side of the apex, the very oblique annulations, and few lamellæ, are characteristics by which this species is easily distinguished.

*Formation and Locality.*—Corniferous limestone, Charlestown, Indiana.

### ZAPHRENTIS CYATHIFORMIS.

*Plate* 15, *Fig.* 19. *Plate* 16, *Fig.* 4.

*Zaphrentis cyathiformis*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 27. August, 1882.

Corallum simple, turbinate, straight or curved, exterior with gentle undulations, comparatively smooth; longitudinal stria-

tions distinct; height of corallum fifty millimeters; base attenuate; diameter of calyx twenty-five millimeters; depth twenty millimeters, sides abruptly descending, a flat area at the bottom fifteen millimeters in diameter, fossette extending from the flat space to the sinistral margin; number of lamellæ, eighty, alternating in size, thickened near the margin, becoming sharp on the sides.

*Formation and Locality.* Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS CONCAVA.

*Plate* 21, *Fig.* 6.

*Zaphrentis concava*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 35. August, 1882.

Corallum simple, turbinate, regularly curved; height twenty-five millimeters; diameter of calyx twenty millimeters; depth ten millimeters; the sides descend abruptly to within four millimeters of the center, where there is a narrow elevation surrounding an abrupt concavity of five millimeters in diameter; fossette narrow and deep, indenting the margin of the concave area and extending to the anterior margin of the calyx; number of lamellæ, seventy, alternating in size, a few extending to the center; tabulæ concave in the center, outer portion bending abruptly downward, intermediate portion convex.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS UNDATA.

*Plate* 20, *Figs.* 7, 8. *Plate* 25, *Fig.* 1.

*Zaphrentis undata*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 33. August, 1882.

Corallum simple, elongate turbinate, gradually and regularly, or abruptly curving, so that one portion is at right angles to the other; exterior with strong regular annulations and numerous moderately strong concentric striæ; tabulæ usually flat, curving downward toward the margin, and extending nearly the entire diameter of the corallum; number of lamellæ, 120, the smaller ones rudimentary. The exterior of this species so closely resembles that of *Heliophyllum annulatum*, that from the

external characters alone it would be difficult to distinguish them; internally, however, they have not the least resemblance to each other.

*Formation and Localities.*—Corniferous limestone, Falls of the Ohio, and Clark county, Indiana.

### ZAPHRENTIS HERZERI.

*Plate* 21, *Figs.* 7, 8, 9.

*Zaphrentis herzeri*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 35. August, 1882.

Corallum simple, turbinate, straight or curved; the anterior side is frequently flattened in young specimens; base acute, regularly expanding to the calyx; exterior with numerous rounded annulations and concentric striæ; external striæ obscure in all the specimens observed; height sometimes forty millimeters, but usually thirty millimeters; diameter of the calyx from fifteen to twenty millimeters; depth from ten to fifteen millimeters; more or less oval; usually flattened near the margin, then abruptly sloping to the center; fossette narrow, extending from the center nearly to the anterior margin; number of lamellæ from sixty to seventy, alternating in size, the smaller ones not more than five millimeters in length; the larger lamellæ extend to the center of the cup, not twisted or elevated.

This species has been included with *Heliophyllum exiguum*, by Dr. C. Rominger, (Geological Survey of Michigan), but the form is different, and there are no traces of heliophylloid structure. It may be distinguished from *Z. ungula* by its less compressed form and the different character of the center of the calyx.

*Formation and Locality.*—Corniferous limestone, Louisville, Kentucky.

### ZAPHRENTIS PLANIMA.

*Plate* 21, *Fig.* 15.

*Zaphrentis planima*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 29. August, 1882.

Corallum simple, turbinate, straight; exterior with undulations of growth; height of corallum sixty millimeters; diame-

ter of calyx thirty millimeters; depth fifteen millimeters; sides, nearly vertical, a flat and smooth area at the bottom, fifteen millimeters in diameter, the fossette consisting of a deep depression at the anterior margin of this area; number of lamellæ from eighty-five to ninety, of nearly uniform thickness, alternating in length; the principal ones faintly indicated on the outer portion of the flat area, sometimes continuing to the center. In one specimen the bottom of the cup is marked by a ridge continued from the fossette.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS DUPLICATA.

*Plate* 21, *Fig.* 3.

*Zaphrentis duplicata*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 32. August, 1882.

Corallum simple, turbinate, attenuate below, straight or slightly curved; exterior with low rounded ridges of growth; external striæ fine, distinct; height of corallum forty-five millimeters; diameter of calyx, thirty millimeters; depth fifteen millimeters; sides nearly vertical, a flat area at the bottom twenty millimeters in diameter; fossette deep and narrow, commencing near the center and extending to the anterior margin; number of lamellæ 110, thickened and rounded near the margin of the cup, extending a short distance on the flattened area at the bottom; the alternate lamellæ coalesce with the others, the lamellæ thus formed fasciculate and coalesce, continuing to the center, where they appear as low tortuous ridges; the tabulæ at the center are elevated, the outer portion bending downward. This species can be distinguished from *Z. frequentata* by its finer lamellæ which are thickened and coalescing at the center, and by the narrow fossette.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS CALCARIFORMIS. †

*Plate* 21, *Fig.* 10, 11.

*Zaphrentis calcariformis*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 33. August, 1882.

Corallum simple, narrowly turbinate, regularly curved; di-

† This species is from the Warsaw group,

ameter of calices in individuals of the same height, varying from ten to fifteen millimeters; height twenty-five millimeters; exterior with frequent undulations and low, rounded annulations; fossette narrow, very deep, commencing at the center and continuing to the posterior margin; the lamellæ extend to the margin; coalescing and forming vertical walls; number of lamellæ fifty, alternating in size; at a distance of two millimeters from the margin the smaller lamellæ coalesce with the others.

This species is easily distinguished by the deep, narrow fossette situate on the posterior side, and the regular coalescing of the lamellæ near the margin.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS OVALIS.

*Plate* 23, *Fig.* 1.

*Zaphrentis ovalis*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 29. August, 1882.

Corallum simple, turbinate, straight or curved, slightly compressed; exterior with numerous constrictions caused by intermittent growth; height fifty millimeters; diameter of calyx, twenty-five millimeters; depth ten millimeters; sides nearly vertical, a flat area at the bottom fifteen millimeters in diameter; fossette consisting of a deep depression at the dextral margin of the flattened area; number of lamellæ seventy-five, uniform in size, extending a short distance upon the tabulæ, and coalescing with them, becoming obsolete, and leaving a smooth area thirteen millimeters in diameter.

Though not observed in the individuals examined, it may prove that, at the margin of the cup, when entire, there are small rudimentary lamellæ, in which case the number given above would be increased.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS CONVOLUTA.

*Plate* 22, *Fig.* 2.

*Zaphrentis convoluta*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 37. August, 1882.

Corallum simple, turbinate, straight or regularly curved,

acute at the base, regularly expanding to the calyx, slightly compressed, oblique; decorticated specimens appearing somewhat smooth; internal striæ not prominent; height of corallum seventy millimeters; diameter of calyx forty millimeters; depth twenty-five millimeters; a central area, twelve millimeters in diameter, flat and smooth; number of lamellæ 100, alternating in size, the smaller ones about fifteen millimeters long; usually from two to four adjacent principal lamellæ coalesce and fasciculate, becoming twisted and extending to within six millimeters of the center; fossette obscure or obsolete.

This species may be recognized by the conspicuous coalescing and fasciculating of the lamellæ, and their decidedly twisted appearance after coalescing.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS COMPRESSA.

*Plate* 21, *Figs.* 4, 5. *Plate* 22, *Fig.* 5.

*Zaphrentis compressa*, ROMINGER. Fossil Corals, 1876, page 151, plate 53.

Corallum broadly turbinate, straight or very slightly curved, flattened, acute at the base, rapidly and regularly expanding; exterior with numerous, rounded, irregular annulations; external costæ, in well preserved specimens, prominent. Height of corallum one hundred millimeters; calyx oval, length seventy-five millimeters; width forty millimeters; sides, nearly vertical, leaving at the bottom a concave area about forty-five millimeters in length, and twenty millimeters in width; fossette, dextral, consisting of a deep oval pit or depression a little to the right of the center, and continuing to the margin of the concavity at the bottom of the calyx. A broad groove extends from the fossette to the sinistral margin at the bottom; on the sides of the calyx the fossette is obsolete; number of lamellæ 190, broadly angular at the margin of the calyx, and nearly equal in size, alternating on the sides; the smaller lamellæ extend to the flattened space at the bottom; the principal lamellæ extend to the fossette and continuing groove, slightly twisted.

This species closely resembles *Z. ungula* in general appear-

ance, but is much larger, the fossette is always dextral and obsolete on the sides, while in *Z. ungula* it is anterior and continues from the center to the margin.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### SAPHRENTIS UNGULA.

*Plate* 23, *Figs.* 2, 3, 4.

*Zaphrentis ungula*, ROMINGER. Fossil Corals, 1876, page 151, plate 53.

Corallum broadly turbinate, flattened, acute at the base, regularly and rapidly expanding; exterior with sharp constrictions; external costæ obscure; corallum slightly and regularly curved; posterior portion regularly rounded, anterior nearly flat; height, thirty millimeters; calyx, thirty millimeters in length; width, twenty millimeters; flat or gently sloping for three or four millimeters from the margin, then regularly and abruptly descending, leaving at the bottom a small flattened area, along the middle of which is a groove at right angles to the fossette, which commences at the center and continues to the anterior margin; on the flattened area at the bottom it is much more conspicuous than on the sides, where there is usually one lamellæ along the middle of the fossette; number of lamellæ eighty, at the margin thickened and of uniform size, becoming very thin, and alternating in size below; the principal lamellæ continue to the groove along the bottom of the calyx, and are slightly twisted.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio. Indiana and Kentucky.

### ZAPHRENTIS CONIGERA.

(See under CLISIOPHYLLUM CONIGERUM.)

### ZAPHRENTIS FUSIFORMIS.

*Plate* 21, *Figs.* 12, 13.

*Zaphrentis fusiformis*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 29. August, 1882.

Corallum simple, turbinate, very slightly curved, a little compressed, upper portion usually constricted; exterior with slight undulations of growth; height, twenty millimeters; diameter

twelve millimeters at a distance of ten millimeters from the base; diameter of calyx eight millimeters; depth five millimeters; at the bottom of the calyx a slightly concave space, three millimeters in diameter; fossette narrow, conspicuous, reaching from near the center to the anterior margin; number of lamellæ sixty, alternating in size, the smaller ones scarcely more than rudimentary, the principal lamellæ extend to the concave area at the bottom of the calyx and terminate abruptly.

This species is easily recognized by its small size, constricted calyx, and the peculiar appearance of the center.

*Formation and Locality.*—Corniferous limestone, near Louisville, Kentucky.

## CYATHOPHYLLUM, *Goldfuss.*

### CYATHOPHYLLUM VESICULATUM.

*Plate* 23, *Fig.* 6.

*Cyathophyllum vesiculatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 41. August, 1882.

Corallum simple, elongate turbinate, attenuate below, curved, regularly expanding to the calyx; exterior with gentle undulations of growth; height thirty-five millimeters; diameter of calyx twenty millimeters; depth fifteen millimeters; sides regularly sloping to the center; number of lamellæ sixty, slightly alternating in size, very thin; the principal lamellæ extend to the center of the calyx, not twisted. The inter-lamellar cysts are small, but very distinct. This character gives to the corallum somewhat the appearance of a *Cystiphyllum.*

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### CYATHOPHYLLUM ARCTIFOSSA.

*Plate* 24, *Figs.* 1, 2.

*Cyathophyllum arctifossa*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 40. August, 1882.

Corallum simple, turbinate, straight or curved; sometimes regularly expanding from a conical apex; at other times the diameter at the base is greater than at a short distance above;

exterior with concentric wrinkles and moderately prominent annulations; height of corallum eighty millimeters; calyx broadly campanulate, having a diameter of fifty millimeters and a depth of twenty-five millimeters; fossette deep, narrow, commencing about eight millimeters from the center and continuing to the anterior margin; number of lamellæ 120, nearly uniform in thickness, alternating in length; the larger ones, as they approach the bottom, fasciculate, a few continue to the center, coalescing with the tabulæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### CYATHOPHYLLUM DEPRESSUM.

*Plate* 24, *Figs.* 3, 4.

*Cyathophyllum depressum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 40. August, 1882.

Corallum simple, turbinate, straight or slightly curved, exterior with annulations and undulations of growth, and very prominent longitudinal striæ, of which there are eight in the space of ten millimeters; height of corallum, eighty millimeters, regularly expanding; diameter of calyx forty millimeters; depth of anterior side thirty-five millimeters; sides parallel with the exterior wall; a flat area at the bottom twenty millimeters in diameter, with a deep depression in the center. The fossette consists of a deep depression sinistral to the center, its continuation on the side is obscurely indicated; number of lamellæ from eighty to ninety, alternating in size, the smaller ones very thin, extending to the flattened space at the bottom of the calyx; the larger lamellæ fasciculate and extend to the center, where they are slightly twisted; the interlamellar cysts are prominent, elongate, sometimes obscuring the smaller lamellæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### CYATHOPHYLLUM IMPOSITUM.

*Plate* 23, *Fig.* 7.

*Cyathophyllum impositum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 40. August, 1882.

Corallum simple, turbinate, straight or slightly curved, gradually expanding; exterior with frequent sharp constrictions caused by intermittent growth, giving the appearance of a series of invaginated calices; external striæ conspicuous; height of corallum eighty millimeters; diameter of the calyx forty millimeters; depth thirty millimeters; sides regularly sloping to the center; a narrow fossette both on the anterior and posterior sides, connected by a shallow depression; number of lamellæ from 100 to 110, alternating in size, somewhat thickened near the margin, very thin and sharp on the sides of the calyx; principal lamellæ extending to the depression at the bottom of the calyx; on the sides of the lamellæ, at right angles to the margin, are numerous rounded striæ, sometimes projecting beyond the margins and forming denticulations, but usually causing the margin to appear obscurely crenulated.

The striæ have the same direction as those of *Heliophyllum*, but they are not sufficiently distinct or continuous to place the species under that genus.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## CLISIOPHYLLUM, *Dana.*

The following species possesses the internal structure of Clisiophyllum according to the original figure of Prof. Dana, and as recognized by Mr. James Thomson, of Edinburgh, in his late publications.

### CLISIOPHYLLUM CONIGERUM.

*Plate* 22, *Figs.* 3, 4.

*Zaphrentis conigera*, ROMINGER. Fossil corals, 1876, page 149, plate 40.

Corallum turbinate or sub-cylindrical, varying in size and proportion; some specimens have a length of three hundred millimeters, and a diameter at the calyx of forty millimeters,

not increasing for half the length; other individuals of one hundred and fifty millimeters in length have a diameter at the calyx of seventy to eighty millimeters; in some specimens the surface has sharp, narrow constrictions at regular intervals, giving a somewhat invaginated aspect; while in others there are prominent annulations at irregular distances; calyx circular, depth from fifteen to thirty millimeters, sides abruptly descending; at the bottom a conical elevation with broad base, varying in height from ten to fifteen millimeters, or more; number of lamellæ 104, in a calyx of thirty millimeters in diameter; strongly alternating in size, principal ones very thin and prominent, extending to the cone at the bottom, where they are spirally twisted and frequently fasciculating.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio, and Clark county, Indiana.

## Genus ACROPHYLLUM, *Thomson & Nicholson.*

Messrs. Thomson and Nicholson have proposed a new genus, *Acrophyllum*, founded upon *Clisiophyllum Oneidaense*, of Billings, which is very properly separated from *Clisiophyllum* as possessing characters quite unlike the typical species of that genus.

In our specimens the tabulæ are strong and well defined, becoming gradually or abruptly elevated as they approach the center. This feature depending in some measure, apparently, upon the external form of the coral, the central portion being usually abruptly conical. There are, however, specimens where the calyx is nearly flat or but slightly elevated in the center. The septa are numerous and well developed, coalescing and curving as they reach the tabulæ; forming prominent, tortuous ridges on the central elevated portion, and becoming complicated with the tabulæ to form the conspicuous central prominence, which under some conditions assumes the character of a solid central axis.

The general structure of the coral is similar to *Zaphrentis*, except for the prominent central elevation of the tabulæ.

## ACROPHYLLUM ONEIDAENSE.

*Figs.* 1, 2, *Page* 302.

*Clisiophyllum oneidaense*, BILLINGS. Canadian Journal, page 128, 1859.
" " ROMINGER. Fossil Corals, 1876.

Corallum simple, turbinate or sub-cylindrical, straight or curved. Examples are extremely variable, some being short and broadly turbinate; one has a height of sixty millimeters and a diameter at the calyx of fifty millimeters, rapidly expanding from an acute base; while another specimen has a height of more than three hundred millimeters and a diameter of only fifty millimeters, the greater part of its length not increasing in diameter; many individuals are somewhat compressed, but this may have resulted from accident; the exterior has numerous constrictions, caused by intermittent growth, and often exhibits an invaginated appearance; external costæ on well preserved specimens, prominent, twelve to fourteen in the space of ten millimeters; often (especially near the base), there are numerous small conical or spiniform nodes. The sides of the calyx are nearly vertical, leaving an area at the bottom almost equal to one-half the width of the calyx, in the center of which is a prominent elevation, varying in height from ten to fifteen millimeters, the width of the base about equal to the height; this projection is caused by the elevation of the tabulæ. The number of lamellæ in a calyx forty-five millimeters in diameter is two hundred, alternating in size, the smaller ones, being merely rudimentary, are confined to the margin of the calyx and are often obsolete. The principal lamellæ are very thin and prominent, extending nearly to the base of the central elevation, fasciculating; and the thickened lamellæ thus formed extend to the apex of the cone; fossette reaching from the base of the elevation to the margin of the calyx, being much more conspicuous on the flat area at the bottom than on the sides; position variable.

This species can always be easily recognized by the exterior alone, which has some resemblance to *Blothrophyllum decorticatum*.

The following figures illustrate the interior characters of the species as presented in two weathered specimens: Fig. 1 is a turbinate form, showing a portion of the calyx with the tabulæ, in the lateral portions gradually rising towards the center. Fig. 2 is a weathered fragment of a nearly cylindrical form, showing the abrupt and extreme elevation of the tabulæ towards the center. The axis in this case is essentially solid, owing to the compactness of the tissue formed by the tabulæ and lamellæ conjoined; to which possibly the infiltration of mineral matter may have contributed.

These figures likewise illustrate the extreme variation of external form which prevails in this species.

Fig. 1.

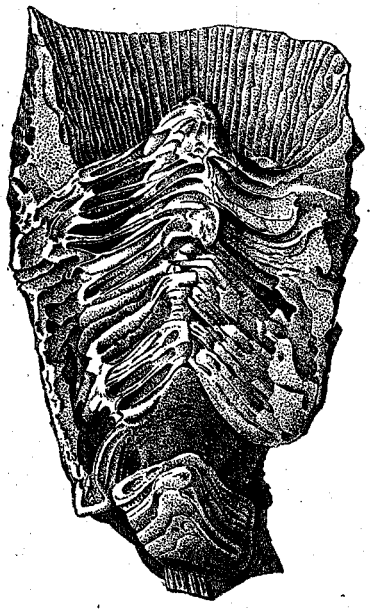
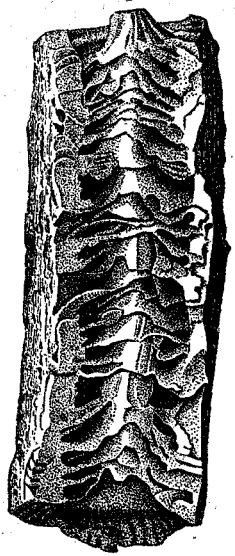


Fig. 2.



*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## DIPHYPHYLLUM, *Lonsdale.*

### DIPHYPHYLLUM APERTUM.

*Plate* 27, *Fig.* 6, *and Plate* 28, *Figs.* 4, 5.

*Diphyphyllum apertum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 54. August, 1882.

Corallum simple, sub-cylindrical, straight or curved, gradually or more rapidly expanding; when decorticated it presents a distinct invaginated appearance; length of one individual, sixty millimeters; calyx campanulate; diameter twenty millimeters; depth ten millimeters; number of lamellæ from sixty to seventy, of nearly uniform size at the margin, alternating below; the principal lamellæ extend to the vertical internal wall; denticulations prominent, ten in the space of five millimeters; inclosed internal area oval or horse-shoe shape, from four to six millimeters in diameter; anterior side indented by a deep, narrow fossette.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### DIPHYPHYLLUM ADNATUM.

*Plate* 27, *Figs.* 7, 8.

*Diphyphyllum adnatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 54. August, 1882.

Corallum sub-cylindrical, simple or compound, increasing by lateral gemmation, frequently in contact for their entire length; exterior with very regular annulations and concentric striæ; longitudinal striæ distinct; diameter varying from twelve to twenty millimeters; calyx campanulate; depth about ten millimeters; number of lamellæ, fifty; uniform in thickness, alternate lamellæ continuing to the inner wall; the space inclosed by the vertical wall is three millimeters in diameter.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### DIPHYPHYLLUM TUMIDULUM.

*Plate* 17, *Figs.* 3, 4.

*Diphyphyllum tumidulum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 55. August, 1882.

Corallum small, simple, increasing by calicular gemmation; length, fifteen millimeters, or less; diameter from three to four

millimeters for about one-half the length, then abruptly expanding; diameter of the calyx from seven to ten millimeters; depth five millimeters; number of lamellæ fifty, alternating in size; denticulations prominent; the inclosed internal area is one millimeter in diameter.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## CYSTIPHYLLUM, *Lonsdale.*

### CYSTIPHYLLUM LATIRADIUM.

*Plate* 28, *Figs.* 8, 9.

*Cystiphyllum latiradium*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 57. August, 1882.

Corallum simple, turbinate, straight or slightly curved, rapidly expanding; exterior with gentle undulations and sharp constrictions; when decorticated it presents a very distinctly invaginated appearance; height of corallum sixty millimeters; calyx broadly campanulate; diameter sixty millimeters; depth twenty millimeters; a flat space at the bottom, about ten millimeters in diameter, occupied by large cysts; near the margin are broad, gently rounded, rudimentary lamellæ of nearly uniform size, six or seven in the space of fifteen millimeters; the cysts first appear at about fifteen millimeters from the margin, becoming larger as they approach the center; the broad plications either end abruptly or are continued on the cysts as fine interrupted striæ. In a transverse section the corallum appears to be formed of thin superimposed laminæ.

In the manner of growth and appearance near the margin, this species is very similar to a CHONOPHYLLUM.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

## BLOTHROPHYLLUM, *Billings.*

### BLOTHROPHYLLUM PROMISSUM.

*Plate* 27, *Fig.* 9, *and Plate* 28, *Figs.* 6, 7.

*Blothrophyllum promissum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 45. August, 1882.

Corallum simple, cylindrical, elongate; diameter from fifteen

to twenty-five millimeters; number of lamellæ seventy, alternating in size; at the bottom of the calyx is a flat area, either smooth or with the lamellæ but faintly indicated.

In the decorticated condition in which this species and *B. sinuosum* occur, it is not possible to separate them by external characters, but in the one species the calyx has the lamellæ extending nearly to the center, abruptly ending and the extremities twisted; the other, *B. promissum*, has a broad, smooth space at the bottom of the calyx, and the lamellæ not twisted. These characters are distinctive.

## HELIOPHYLLUM, *Hall.*

### HELIOPHYLLUM ALTERNATUM.

*Plate* 24, *Figs.* 5, 6.

*Heliophyllum alternatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 45. August, 1883.

Corallum simple, turbinate, usually straight; height forty-five millimeters; diameter of calyx thirty-five millimeters; depth twenty millimeters; sides nearly vertical, bottom flat; number of lamellæ, from seventy to eighty, alternating in size, the larger ones very prominent, extending nearly to the center of the cup, coalescing and forming small, irregular, central, elevations; at the margin of the calyx the lamellæ are thick and rounded, growing thinner as they approach the bottom; denticulations of the lamellæ prominent, appearing as spinules, six in the space of five millimeters. This species may be distinguished by the difference in the size of the lamellæ, and the nearly vertical sides of the calyx.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM INFUNDIBULUM.

*Plate* 23, *Fig.* 8, *and Plate* 24, *Fig.* 7.

*Heliophyllum infundibulum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History.

Corallum turbinate, straight or curved; exterior with gentle undulations of growth and fine concentric striæ, sometimes sharply constricted by intermittent growth; diameter varying

in individuals of the same height from fifteen to twenty-five millimeters; diameter of calyx twenty-five millimeters, depth fifteen millimeters, regularly and gently concave from the margin to the center; the form of the calyx is a short, inverted cone; number of lamellæ from seventy to eighty, sometimes uniform in size, at other times alternating; the larger lamellæ continue to the center, slightly twisted; denticulations fine; no fossette.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM INVAGINATUM.

*Plate* 28, *Fig.* 1.

*Heliophyllum invaginatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 47. August, 1882.

Corallum elongate, gradually expanding; when decorticated it has the appearance of consisting of a series of invaginated calices; height of a full grown specimen, thirteen centimeters; diameter of calyx fifty millimeters; depth thirty millimeters; when the lamellæ are perfect the calyx is somewhat campanulate, when broken away the sides of the calyx are more nearly vertical, and the bottom is flat or elevated at the center; number of lamellæ ninety; of nearly uniform size at the margin, alternating on the sides, the principal lamellæ extending to the center are flexuous or slightly twisted, very thin and prominent, from five to seven denticulations in the space of five millimeters, extending to within forty millimeters of the center of the calyx.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM SCYPHULUS.

*Plate* 26, *Fig.* 5, *and Plate* 28, *Figs.* 2, 3.

*Heliophyllum scyphulus*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 51. August, 1882.

Corallum simple, turbinate, regularly curved; surface with frequent narrow annulations of growth and fine striations, sometimes with comparatively broad undulations. The greater portion of specimens observed are from twenty to twenty-five millimeters in height; diameter of calyx about equal to the

height; depth fifteen millimeters; a flat or slightly convex area at the bottom of the calyx when the lamellæ are perfect; fossette situated anteriorly, not extending to the margin; number of lamellæ sixty; uniform in size at the margin, alternating below, the larger ones extending to the center, slightly twisted; occasionally one or more extending from margin to margin; center of tabulæ flat, the outer portion bending abruptly downward; from three to five denticulations in the space of five millimeters, at a distance from the margin very prominent and spiniform.

This species differs from *H. Halli* in the form of the calyx, thinner lamellæ, and more distant denticulation.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM TENUIMURALE.

*Plate* 27, *Figs.* 2, 3.

*Heliophyllum tenuimurale*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 51. August, 1882.

Corallum simple, turbinate, curved, usually decorticated, internal costæ prominent; height of corallum thirty millimeters; diameter of calyx twenty-five millimeters; depth fifteen millimeters; sides abruptly sloping, leaving at the bottom a convex area ten millimeters in diameter; fossette extending from near the center to the anterior margin of the calyx; a depression extends from the fossette across the elevation at the bottom of the calyx, connecting with a rudimentary fossette on the posterior side; number of lamellæ, ninety, alternating in size, the smaller ones rudimentary; the larger lamellæ extend to the center of the calyx, where they are elevated and twisted; seven or eight denticulations in the space of five millimeters.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM ANNULATUM.

*Plate* 23, *Fig.* 12, *and Plate* 25, *Figs.* 2, 3.

*Heliophyllum annulatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 48. August, 1882.

Corallum simple, elongate, gradually expanding, usually compressed; exterior with prominent rounded or sub-angular an-

nulations of growth, which are sometimes at regular distances apart, also concentric wrinkles and fine striations; longitudinal striæ distinct; number of lamellæ from sixty to seventy-five; height of corallum from one hundred to one hundred and fifty millimeters, or more; often extremely attenuate, and flattened from compression. In many examples the exterior does not well exhibit the generic characters, but longitudinal sections show the heliophylloid structure.

*Formation and Locality.*—Corniferous limestone, Scott and Clark counties, Indiana, and Young's farm, Erie county, New York.

### HELIOPHYLLUM COMPACTUM.

*Plate* 25, *Fig.* 5.

*Heliophyllum compactum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 48. August, 1882.

Corallum small, sub-cylindricl or elongate turbinate, straight or slightly curved, gradually expanding; exterior with broad undulations of growth, concentric wrinkles and fine striations; height of corallum fifty millimeters; diameter of calyx twenty millimeters; depth fifteen millimeters; sides nearly vertical, abruptly expanding near the margin; a flat area at the bottom of the calyx eight millimeters in diameter; number of lamellæ, seventy, nearly uniform in size at the margin of the calyx, alternating on the sides; the principal lamellæ extend on the flattened area at the bottom, abruptly coalescing with the tabulæ, leaving a smooth space five millimeters in diameter; denticulations fine, ten in the space of five millimeters; no fossette. The tabulæ are nearly flat at the middle, bending abruptly downward near their outer margins.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM DISTANS.

*Plate* 26, *Figs.* 1, 2.

*Heliophyllum distans*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 50. August, 1882.

Corallum simple, turbinate, straight or curved; height forty-five millimeters; diameter of calyx forty-five millimeters, depth

twenty millimeters; the walls of the calyx, for a space of eight millimeters from the margin are flat, then abruptly descending; at the center an area fifteen millimeters in diameter is gently convex; number of lamellæ seventy, of uniform size at the margin, alternating below; the principal lamellæ extend nearly to the center of the calyx; denticulations thin, three in the space of five millimeters.

In general form and appearance this species is similar to *H. Halli*, but the lamellæ are much thinner, and the denticulations are at a greater distance apart, there being in that one six in an equal space occupied by three in this species.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM INCRASSATUM.

*Plate* 26, *Figs.* 3, 4.

*Heliophyllum incrassatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 46. August, 1882.

Corallum simple, turbinate; height forty millimeters; diameter of calyx thirty millimeters; depth fifteen millimeters; sides near the margin flat or rounded, then quite abruptly descending, a flat area at the bottom ten millimeters in diameter; fossette conspicuous; number of lamellæ fifty-six, alternating in size, the smaller ones about one-third the thickness of the others; the greater portion of the lamellæ extend only to the flat space at the bottom of the calyx, from that point about fifteen are very much thickened and extend to the center, straight or slightly flexuous; denticulations moderately prominent, from six to eight in the space of five millimeters; near the margin they are wide, and become narrow and spiniform below.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM FECUNDUM.

*Plate* 26, *Fig.* 6, *and Plate* 27, *Figs.* 4, 5.

*Heliophyllum fecundum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 49. August, 1882.

Corallum small, increasing by calicular gemmation, sometimes connected for nearly their entire length; height of a mature individual sixty-five millimeters; diameter of calyx

thirteen millimeters; for a distance of four millimeters from the margin the walls of the cup are nearly flat, then abruptly descending to a smooth area, four millimeters in diameter at the bottom; number of lamellæ, seventy, of uniform size, extending to the flat space at the bottom of the calyx; denticulations minute, no fossette. From one calyx, only twelve millimeters in diameter, proceed five buds.

This species is easily distinguished from *H. gemmatum* by its smaller size and different form of calyx.

*Formation and Locality.* Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM GEMMATUM.

*Plate* 26, *Fig.* 12.

*Heliophyllum gemmatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 49. August, 1882.

Corallum rapidly increasing in numbers by calicular gemmation; height usually from twenty-five to thirty millimeters; diameter of calyx twenty millimeters; depth ten millimeters; sides regularly sloping; a flat and smooth area at the bottom of the calyx three millimeters in diameter; number of lamellæ seventy; sometimes uniform in size, sometimes alternating, extending to the flat space at the center of the calyx; denticulations minute; sixteen in the space of five millimeters; fossette small.

In nearly all the specimens seen there are three to five buds growing from the parent corallum.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM ACUMINATUM.

*Plate* 26, *Fig.* 11.

*Heliophyllum acuminatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 46. August, 1882.

Corallum simple, turbinate, regularly curved, length of anterior side fifty millimeters; of posterior side twenty-five millimeters; diameter of calyx forty millimeters; depth thirty millimeters; a depressed convex space at the bottom twenty-five millimeters in diameter; fossette conspicuous, extending from the convex space at the bottom to the anterior margin;

number of lamellæ eighty, alternating in size, margins broadly angular; the larger lamellæ extend upon the tabulæ, but do not reach the center; denticulations very prominent, sometimes extending nearly one millimeter beyond the margins of the lamellæ, from three to four in the space of five millimeters.

*Formation and Locality.*—Corniferous limestone, Ontario.

### HELIOPHYLLUM SORDIDUM.

*Plate* 26, *Figs.* 9, 10.

*Heliophyllum sordidum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, p. 52. August, 1882.

Corallum small, simple, turbinate, height from fifteen to twenty millimeters; diameter of calyx equal to the height. Numerous individuals of this species have been observed, but they are invariably decorticated and the margins of the calyx are broken away, so that the true form can not be accurately determined; a conspicuous fossette extends from near the center to the anterior margin; frequently along the middle of the fossette there is a prominent lamellæ; number of lamellæ from eighty to ninety, alternating in size, the larger ones thick, coalescing, fasciculating, and extending to the center, where they are twisted. Owing to the breaking away of the lamellæ near the margin, the denticulations seldom appear.

This is easily recognized as a HELIOPHYLLUM from the character of the internal costæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM CORNICULUM.

*Plate* 23, *Fig.* 9.

*Caryophylla cornicula*, LESUEUR. 1820.
*Zaphrentis phrygia*, RAFINESQUE & CLIFFORD. 1820.
*Caninia punctata*, D'ORBIGNY. 1850.
*Cyathophyllum ammonis, delitatum and comtum*, DECASTELNAU. Terr. Sil. de l'Amer. du Nord. Pl. xxi, F. 1–3.
*Zaphrentis cornicula*, EDWARDS & HAIME. Pal. Foss. des Terr. Pal., Pl. vi, F. 1.
*Cyathophyllum corniculum*, ROMINGER. Fossil corals, 1876.

Corallum simple, turbinate, regularly curved, acute at the base, rapidly expanding; exterior with shallow constrictions; the surface usually comparatively smooth; on well preserved

specimens the costæ are prominent; height usually from thirty to thirty-five millimeters, diameter from twenty to twenty-five millimeters, though examples have been found seventy millimeters in height and forty-five millimeters in diameter; one calyx of twenty-five millimeters diameter has a depth of fifteen millimeters; the sides descend regularly and abruptly, leaving at the bottom a flattened area about fifteen millimeters in diameter; fossette commencing just posterior to the center and continuing to the posterior margin, much more prominent on the bottom of the calyx than on the sides; number of lamellæ, seventy, alternating in size; the smaller lamellæ extend to the flattened area at the bottom of the calyx; the larger lamellæ continue to the center, slightly twisted; from six to eight denticulations in the space of five millimeters; near the margins of the cup they are thin and somewhat obscure, on the sides they are very prominent and spiniform. This species is very common, and found in New York and Canada, in Indiana, Ohio and other Western States. Although usually placed in the genus *Zaphrentis*, this form presents the characteristics of the genus *Heliophyllum*.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio, and various other localities.

### HELIOPHYLLUM NETTELROTHI.

*Plate* 26, *Fig*, 8.

*Heliophyllum nettelrothi*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 51, August, 1882.

Corallum simple, elongate turbinate, regularly or irregularly curved. The numerous specimens observed are decorticated. The internal structure is as follows: A central area is occupied by the flat portion of the tabulæ; the tabulæ turn upward, and for a distance of ten or fifteen millimeters are nearly vertical, forming a cylindrical cavity, then turn outward and downward; in one example the flat portion of the tabulæ is eight millimeters in diameter; a space of thirty millimeters in diameter is occupied by the tabulæ and lamellæ without intermediate structure; then occur small intermediate cysts, having a direction toward the margin, and the heliophylloid rays, having

a direction toward the center. The outer area consists of a series of the projecting margins of the invaginated calices, the lamellæ of which have, on their sides and margins, prominent rays and denticulations, but no vesicles. A calyx of forty millimeters in diameter slopes abruptly to the depth of fifteen millimeters; it is then flat for a distance of eight millimeters, then turns abruptly downward and continues vertically for a distance of about thirty millimeters; transverse section (of the latter portion) usually oval; number of lamellæ from ninety to one hundred, alternating in size, the larger ones continuing to the center of the cup, though somewhat obscured on the lower portion of the vertical wall; denticulations prominent, six or seven in the space of five millimeters; on the sides of the lamellæ are oblique, coarse, rounded striations; these end abruptly at two conspicuous longitudinal grooves; from these grooves to the outer area, a space of about five millimeters, there are numerous small cysts; on the outer area there are prominent heliophylloid striæ.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM DENTICULATUM.

*Plate* 26, *Fig.* 7.

*Heliophyllum denticulatum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 52. August, 1882.

Corallum simple, turbinate, curved in sometimes more than one direction; exterior with numerous concentric wrinkles and fine striæ; external costæ coarse and prominent; height of corallum forty-five millimeters; diameter of calyx seventeen millimeters; depth ten millimeters, broadly campanulate; fossette commencing near the center and extending to the margin; number of lamellæ fifty, alternating in size, principal lamellæ coalescing, fasciculating, and extending to the center.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM LATERICRESCENS.

*Plate* 27, *Fig.* 1.

*Heliophyllum latericrescens*, HALL. Thirty-fifth Annual Report of the State Museum of Natural History, advance sheets, page 49. August, 1882.

Corallum sub-cylindrical, slightly compressed, simple or compound, increasing by lateral gemmation; exterior with numerous sharp annulations of growth, concentric wrinkles and fine striæ; the largest specimen observed is ten centimeters in length, with a nearly uniform diameter of thirty millimeters; depth of calyx fifteen millimeters, somewhat campanulate, center elevated; number of lamellæ from ninety to one hundred, uniform in size near the margin of the cup, alternating below; the principal lamellæ extending to the center of the cup are twisted and elevated, forming a false columella; denticulations fine, eighteen in the space of five millimeters.

In its manner of growth, deep calyx with false columella, very fine lamellæ and denticulations, this species is easily distinguished from any others.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### HELIOPHYLLUM ÆQUUM.

*Plate* 23, *Figs.* 10, 11.

*Heliophyllum æquum*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 50. August, 1882.

Corallum simple, more or less curved, when decorticated having a decidedly invaginated appearance; height eighty millimeters; diameter of calyx thirty millimeters; depth twenty millimeters; the margin sub-quadrangular in outline, sides nearly vertical, a flat, smooth area at the bottom fifteen millimeters in diameter; number of lamellæ ninety, alternating in size; the larger ones are faintly indicated for a short distance on the tabulæ at the bottom of the calyx; fossette narrow and deep. This species may be known by the broad, smooth area at the bottom of the calyx.

*Formation and Locality.*—Corniferous limestone, Falls of the Ohio.

### ZAPHRENTIS COLLETTI.

*Plate* 18, *Figs.* 12, 13.

*Zaphrentis colletti*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History, advance sheets, page 28. August, 1882.

Corallum simple, turbinate, curved, usually compressed near the base and for some distance above; calyx circular; exterior with strong, rounded ridges of growth; longitudinal striæ prominent; length of the posterior side of an adult specimen, forty millimeters; length of the anterior side, seventy millimeters; calyx forty-five millimeters in diameter; sides gradually sloping; an area at the bottom ten millimeters in diameter, very slightly elevated, smooth or rugose from the contorted lamellæ; number of lamellæ from seventy to eighty, nearly uniform in size at the margin, alternating below, the principal ones extending to the elevated area at the bottom.

In different specimens there is considerable variation in the lamellæ. Sometimes the smaller coalesce with the larger ones; lamellæ with thick, rounded margins, which continue thus to the bottom of the calyx. In other specimens they are nearly uniform at the margin, alternate ones becoming obsolete on the sides, leaving the principal lamellæ sharp. In some specimens all the lamellæ on the posterior side extend to the bottom of the calyx, giving to that side a much finer appearance than the other.

*Formation and Locality.*—Corniferous limestone, Crab Orchard, Kentucky.

### ZAPHRENTIS (AMPLEXUS?) CRUCIFORME.

*Plate* 22, *Figs.* 6, 7.

*Zaphrentis* (*Amplexus*) *cruciforme*, HALL. Thirty-fifth Annual Report of the New York State Museum of Natural History. Unpublished.

Corallum simple, elongate turbinate or sub-cylindrical, curved, very gradually increasing in diameter; exterior with irregular annulations and constrictions; longitudinal striæ very distinct. On the convex side, near the base, are several processes, which probably served for points of attachment to a foreign body. Height of corallum, forty millimeters; diameter at base, ten millimeters; calyx, fifteen millimeters in diameter, sides

nearly vertical; depth, twelve millimeters; bottom of calyx flat, smooth; number of lamellæ about fifty, alternating in size; the smaller lamellæ rudimentary and scarcely perceptible at a short distance from the margin, thus giving to the calyx a coarsely lamellate appearance.

*Formation and Locality.*—Corniferous limestone; Falls of the Ohio.

### ZAPHRENTIS TEREBRATA.

*Plate* 23, *Fig.* 5.

*Zaphrentis Terebrata*, HALL. 35th An. Rep. N. Y. St. Mus. Nat. Hist. Unpublished.

Corallum simple, turbinate, attenuate below, moderately curved; exterior with fine longitudinal striæ and a few undulations of growth; height about sixty millimeters or more; calyx subelliptical, the greatest diameter about thirty millimeters; lamellæ strong, about fifty (with an equal number of rudimentary ones), extending more than half way to the center, when they turn abruptly downward, their margins becoming laterally bent, thickened and sometimes coalescing, leaving a very narrow, deep cavity; fossette anterior, narrow, well defined, with a single ray in the bottom and one or two more toward the margin of the cup.

This species differs from *Z. ovalis*, fig. 1, of same plate, in its much smoother exterior, its coarser and more extended lamellæ, and narrow, deep calyx. From Z. planima, which it somewhat resembles in exterior form, it differs in the stronger, more extended and less numerous lamellæ, and much narrower calyx.

*Formation and Locality.*—In the Corniferous limestone, at the Falls of the Ohio.

### CYATHOPHYLLUM CONCENTRICUM.

*Plate* 21, *Fig.* 14.

*Cyathophyllum concentricum*, HALL. 35th An. Rep. N. Y. St. Mus. Nat. Hist. Adv. sheets, p. 42, Aug. 1882.

Corallum simple, turbinate, regularly curved, solid exterior with undulations of growth and numerous fine concentric, rugose striæ, longitudinal striæ distinct; height of corallum, fifty

millimeters; calyx, thirty millimeters in diameter; depth, twenty millimeters; sides regularly concave; a space at the bottom ten millimeters in diameter, flat; fossette extending from near the center to the anterior margin; number of lamellæ, 100, nearly uniform in size at the margin of the calyx, alternating below. In some specimens the principal lamellæ extend to the margin of the flattened area below, ending abruptly, leaving the central portion smooth; in others they extend to the center, though becoming abruptly much smaller at the margin of this area. When decorticated the internal striæ are crenulated or united by septa.

*Formation and Locality.*—Corniferous limestone; Falls of the Ohio.

## COLEOPHYLLUM, *Hall.*

*Coleophyllum*, HALL. 35th An. Rep N. Y. St. Mus. Nat. His. Unpublished.

Cyathophylloid corals, growing simply; the substance composed chiefly of a series of closely arranged, invaginated tabulæ, which are more or less oblique to the axis; rays obscure or obsolescent; calices oblique.

Owing to the partial development or incomplete continuity of the tabulæ, broad shallow vesicles are sometimes formed.

### COLEOPHYLLUM, *Romingeri.*

*Plate* 24, *Figs.* 8, 9.

*Coleophyllum*, ROMINGERI. 35th An. Rep. N. Y. St. Mus. Nat. His. Unpublished.

Corallum simple, straight, erect. Tabulæ extremely oblique, closely arranged, scarcely united along the posterior median line; rays fine, obscure, becoming obsolete toward the middle of the shallow calyx, and converging toward the posterior fossette. Base of attachment expanded.

The specimen figured is a straight, erect form, partially silicified and decorticated. The exterior had originally fine longitudinal striæ. In its present condition the posterior side is marked by a narrow slit or fissure, which is apparently due to a deep fossette on this side, and has become conspicuous by the removal of the epitheca.

*Formation and Locality.*—Corniferous limestone; Falls of the Ohio.

### COLEOPHYLLUM PYRIFORME.

*Plate* 24, *Fig.* 10.

*Coleophyllum pyriforme.* Thirty-fifth Annual Report of the State Museum of Natural History. Unpublished.

Corallum obliquely turbinate, curved, regularly enlarging from the apex; calyx of moderate depth, oblique, much shallower at the posterior side; the invaginated tabulæ closely arranged, and marked by a fossette on the posterior side; rays fine, converging and fasciculating towards the fossette, the rays on the posterior side having a coarser aspect. Exterior marked by longitudinal striæ, and on the convex side by distinct annulations.

This species has a neat symmetrical form, with broad elliptical calyx. The specimens are silicified, and on that account the parts are not so clearly defined.

*Formation and Locality.*—Corniferous limestone; Falls of the Ohio.

Other species of this genus are known in the Upper Helderberg limestone, in the State of New York.

ALBANY, N. Y., February 8, 1883.

PROF. JOHN COLLETT,
*State Geologist of Indiana:*

DEAR SIR—Referring to our correspondence regarding the Spergen Hill fossils, and the preparation of a memoir upon the same, I can only repeat what I have already written. Such a memoir can not be properly completed in time for your present report, and I can only express my regret that the exigencies of your work, as you have stated to me, require some publication on the subject. I had hoped to have the much desired opportunity for such a revision of my former work as this occasion would have afforded, but any publication you may make at this time will preclude the necessity or desirability of such a memoir in the future. In the meantime I send you the following memoranda in regard to the original paper, which, perhaps, you may think it well to put upon record:

In November, 1856, I presented to the Albany Institute a paper entitled "Descriptions of New Species of Fossils, from the Carboniferous Limestones of Indiana and Illinois." This paper was prefaced by some remarks upon the subdivisions of the carboniferous limestones of the Mississippi Valley, which are now well recognized among geologists, and need not be here repeated.

The remarks and comparisons accompanying the specific descriptions of these fossils were omitted from the printed paper (except in the first two species), as the matter would otherwise have exceeded the space allotted to it in the volume. A manuscript copy of these remarks was, however, bound with my library copy of the paper, with the intention and expectation of republishing the whole in a more extended form, with illustrations of the species. Some years since, arrangements had been partially made to have this illustrated paper appear in the Transactions of the Albany Institute, but the plan was not

carried out, and in the meantime the original collection had become the property of the American Museum of Natural History, in New York city.

Sometime, about two years since, you requested me to prepare a revision of this paper, with illustrations, to be published in the Geological Report of Indiana. On application to the American Museum for a loan of the specimens for this purpose, I was informed that they were already in hand and considerably progressed for illustration in the museum publications. Thus circumstanced, it was out of my power to comply with your request, as I had in my possession but an incomplete series of specimens from Spergen Hill, and rocks of that age in other localities. The collections more recently sent to me by yourself, from the Indiana Geological Survey, have supplemented in a great degree my own collections, and have added other species, making the representation of the fauna pretty complete. This collection would have enabled me to make, as you desired, a more extended memoir upon the fossils of these strata. Your decision to publish the very excellent plates of the American Museum Bulletin, renders it superfluous to continue this work, since it would be in part a repetition of what you will publish, or, otherwise, supplemental to it.

Following the descriptions of the species, as originally published, I have appended a copy of the remarks and comparisons accompanying each one, as these were written for the original paper, and which have not before been published. Any observations of later date are inclosed in brackets.

# FORAMINIFERA.

## ENDOTHYRA, *Phillips.*

### ENDOTHYRA BALEYI.

*Plate* 32; *Figs.* 34–36.

*Rotalia baleyi*, HALL. Trans. Alb. Inst., vol. iv, p. 34; 1882.
*Endothyra baleyi*, (Hall sp.) Whitfield, Bulletin 3, Am. Mus. Nat. Hist., p. 42, pl. 9, figs. 34–36; 1882.
Compare *Endothyra bowmani*, PHILLIPS.
Compare *Involutina lobata*, BRADY. See Palæontographical Soc., London, vol. xxx, p. 92, pl. 5, figs. 1–4.

Shell depressed, orbicular, sub-equally convex above and below, smooth, margin rounded, indented by the septa; spire depressed, involved; last volution slightly oblique, consisting of eight loculi; aperture contracted.

The general form of this fossil is depressed, globular, with the involutions deviating slightly from the same plane. Not unfrequently, however, the spire ascends in a greater or less degree, and one or more loculi become visible beyond the single volution. Sometimes seven loculi only are visible in the volutions. The surface is smooth under an ordinary magnifier, and the outline is indented at the septa.

This minute fossil is the first one of the Forminifera which has fallen under our observation in the carboniferous limestone (except Fusulina). A single species of this genus, from the carboniferous limestone of Europe, has been described by Ehrenberg, who asserts, also, that he has evidence of the existence of foraminifera in the lower fossiliferous strata.

It gives me great pleasure to offer the slight tribute of the name of this ancient species to one who has done so much for science in our country, and of whom it would be superfluous for me to say that he stands at the head of his department;—of whose quiet, untiring zeal, patient investigation and philosophical deduction, every student of science must speak with pride and satisfaction.

*Localities.*—Alton, Ill.; Spergen Hill, Bloomington and Lanesville, Ind.

# ECHINODERMATA.

## PENTREMITES, *Say.*

### PENTREMITES KONINCKANA.

*Plate* 32, *Fig.* 33.

*Pentremites koninckana*, HALL. Trans. Alb. Inst., vol. 4, p. 4. 1856.
*Pentremites koninckana*, HALL. Geol. Iowa, p. 656, pl. 22, fig. 11. 1858.
*Pentremites koninckana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 43, pl. 9, fig. 33.

Small, globose, or sub-pyriform, upper part rounded, base sub-pyramidal, angular; basal plates small, the lateral edges short and covered by the column, allowing the base of three of the radial plates to come within the limits of the column area, the two other plates resting upon the longer sides of the larger basal plates. Radial plates short, convex in the middle and sloping to the sides, widening a little from the base upwards, and divided only half way down for the reception of the pseudo-ambulacral areas; interradial plates minute, linear or tapering very gradually upwards to a point, and having two extremely short oblique sides below. Pseudo-ambulacral areas broad, nearly plane, and extending only about half way from the summit to the base, rather deeply impressed at their rounded lower ends; poral plates varying from six to thirteen. Oral aperture small, pentagonal; anal aperture large, oval; ovarian opening small, nearly round; surface very finely and beautifully striated; striæ on the sides of the radial plates nearly vertical, but on the lower part they are deflected obliquely across so as to meet at an obtuse angle on the center below the ambulacral areas. Column at its junction with the body round, relatively very large. Length, one-twelfth to one-fourth of an inch.

This species resembles *P. caryophyllatus* of De Koninck, (*crinoides du Terrain carbonifere de la Belgique*), but differs in the shorter base and peculiarity of the basal plates, as well as in the interradial plates, which in one species are extremely small and almost linear, the one on the anal side extending into that aperture. A single individual shows a nearly entire obliteration of one of the pseudo-ambulacral spaces.

*Localities.*—Alton, Ill.; Spergen Hill, Lanesville, and Bloomington, Ind.

## PENTREMITES CONOIDEUS.

*Plate* 32, *Fig.* 32.

*Pentremites conoideus*, HALL. Trans. Alb. Inst., vol. iv, p. 5. 1856.
*Pentremites conoideus*, HALL. Geol. Rept. Iowa, p. 655, pl. 22, figs. 8–10. 1858.
*Pentremites conoideus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 44, pl. 9, fig. 32. 1882.

General form conoidal or pyramidal, with the angles rounded; base sub-truncate; apex a little flattened; plates of the base somewhat flattened; radial plates extremely elongated and deeply divided for the reception of the pseudo-ambulacral areas; interradial plates deeply inserted between the radial plates, long, lanceolate, and very acutely pointed above; pseudo-ambulacral spaces very elongate, narrow, extending nearly to the base, with sides sub-parallel, convex along the median line; median line sharply depressed; poral plates varying with age from twenty-five to fifty; ovarian apertures circular; anal aperture ovate and much larger than the others. Surface marked by fine, closely arranged striæ, which on the radial plates are parallel to the margins till near the summit, where they are stronger and diverge from the suture; striæ on the interradial plates diverging from the center.

Length, from one-fourth to three-fourths of an inch.

In young specimens the base is more extended and the poral pieces much fewer than in older specimens.

Associated with this species and having a similar general aspect, I have observed a single specimen, having a length of three-fourths of an inch, of an obtusely quadrangular form and having but four pseudo-ambulacral areas, one of them being much wider than the others. There are, however, five ovarian openings at the summit. This appears to be an individual where the two adjacent sides of the radial plates have never been developed, while at the same time an effort has been made to preserve the symmetry of the ovarian openings.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

# BRACHIOPODA.

## ORTHIS, *Dalman.*

### ORTHIS DUBIA.

*Plate* 29, *Figs.* 1–5.

*Orthis dubia*, HALL. Trans. Alb., Inst., vol. 4, p. 12. 1856.
*Orthis dubia*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 45, pl. 6, figs. 1–5. 1882.

Shell circular or oval-ovate, valves nearly equally convex. The dorsal valve somewhat more rotund; ventral valve flattened in the middle, with a broad depression extending thence to the front of the shell, giving it a sinuous outline; beak of ventral valve extended beyond the opposite valve, slightly incurved with a triangular foramen; area very small and (with the foramen of the ventral valve) nearly covered by the beak of the dorsal valve which curves towards the opposite valve, bringing the two almost in contact at their margins. Surface marked by fine rounded, closely arranged striæ, which increase by bifurcation and implantation; the striæ down the mesial depression are distinctly tubular, with minute, pore-like openings at intervals, directed downwards. Minute pore-like openings are sometimes seen on other parts of the shell, but never so conspicuous as in the ventral sinus.

Length, .09 to .45; width, .10 to .45 of an inch.

This species is extremely like *O. michelina*, but does not attain more than one-tenth the size of the larger forms of that species. It differs likewise in the greater convexity of the dorsal valve near the lateral margins, and in having a more distinctly defined mesial depression or sinus in the ventral valve. The beaks are also more prominent, especially that of the ventral valve. It is barely possible that this may be the young of *O. michelina*. [Compare with *O. theimii White.*]

We know a species in the Helderberg which in its young state has both valves nearly equally convex with prominent beak, while in maturing it becomes flattened and the ventral valve concave with the edges elevated, while in some stages of growth there are indications of a broad shallow sinus down the center of the ventral valve.

*Localities.*—Spergen Hill, Paynter's Hill, Lanesville, and Bloomington, Indiana.

STREPTORHYNCHUS (ORTHIS) UMBRACULUM (Schlot.)

There are several small specimens in the collection which appear to be identical with *O. umbraculum*, The specimens are scarcely more than half an inch in diameter.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## PRODUCTUS, *Sowerby.*

### PRODUCTUS BISERIATUS.

*Plate* 29, *Figs.* 8–12.

*Productus biseriatus*, HALL. Trans. Alb. Inst., vol. iv, p. 12. 1856.
*Productus biseriatus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 46, pl. 6, figs. 8–12. 1882.

Shell longitudinally ovate, ventral valve extremely gibbous, without sinus, arcuate, marked by five or six elevated distant concentric undulations, which are ornamented upon their upper margins by a single row of elongate pustules or nodes, and on their middle and basal margins by numerous smaller granulations; beak attenuate and extremely arcuate; dorsal valve semi-oval, flattened near the base, having the greatest concavity near the beak, which is obtuse; surface of the dorsal valve marked by eight or nine closely-arranged concentric bands, which are marked by granulations, as in the ventral valve; hinge-line scarcely so long as the greatest width of the shell; extremities rounded.

This species is allied to *P. elegans*, of McCoy. (See Synopsis of the Carb. Fossils of Ireland, pl. 18, fig. 13, and British Pal. Foss., pl. 3, 4, fig. 4.) It has likewise some resemblance to *P. fimbriatus* (Sow. T., 459, f. 1, vol. v, de Koninck Monog. Productus, etc., p. 127, pl. 21.) It differs from the latter, however, in having the finer granulations on the lower margins of the concentric band, while *P. fimbriatus* has the larger nodes only, and these are of less proportional size than in our shell. It approaches in character the young of *P. punctatus*, but is narrower, and the beak of the ventral valve is more slender. There is no indication of a ventral sinus.

*Localities.*—Alton, Illinois; Spergen Hill, Paynter's Hill, and Bloomington, Indiana.

### PRODUCTUS INDIANENSIS.

*Plate* 29, *Figs.* 6, 7.

*Productus Indianensis*, HALL. Trans. Alb. Inst., vol. iv, p. 13. 1882.
*Productus Indianensis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 47, pl. 6, figs. 6, 7. 1882.

Shell sub-ovate, gibbous, inflated; ventral valve without sinus, gradually contracting towards the beak, which is large and strongly arcuate, obtuse at the extremity and very gibbous below; surface pustulose, or aculeate, marked by extremely fine, concentric striæ, and a few irregular undulations; pustules or bases of spines irregularly distributed over the surface of the shell, with a linear series down each side below the hinge extremity; hinge-line apparently less than the width of the shell.

This species resembles *P. subaculeatus* (Murchison, de Koninck, Monog., p. 142, pl. 16, fig. 4), but our shell is narrower, more extremely gibbous in the center, and more gradually contracting toward the beak, which, also, is more gibbous and more strongly arcuate. The bases of the spines or tubes are likewise proportionally much smaller than in *P. subaculeatus*.

*Locality.*—Spergen Hill, Indiana.

## SPIRIFERA, *Sowerby.*

### SPIRIFERA BIFURCATA.

*Plate* 29, *Figs.* 13, 15.

*Spirifera bifurcata*, HALL. Trans. Alb. Inst., vol. iv, p. 8. 1856.
*Spirifera bifurcata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 47, pl. 6, figs. 13–15. 1882.

Shell semi-elliptical in general form; ventral valve gibbous; dorsal valve, depressed convex; plications, seven or eight, which appear to coalesce towards the cardinal margin; mesial fold with a defined depression in the center, reaching half way to the beak; surface longitudinally striated and concentrically marked by fine lines.

Length, .09; width, .11 of an inch.

In worn specimens the longitudinal striæ are often obliterated, and the plications have the apearance of bifurcating. In general form the shell differs little from *spiriferina Norwoodana*,

but may be distinguished by the presence of longitudinal striæ and finer concentric lines, while the plications are less strong and the whole shell is less robust.

*Locality.*—Spergen Hill, Indiana. Spiriferina (spirifer) spinosa (Norwood and Pratten) occurs at Bloomington, Indiana, and above Alton, Illinois, in the same association with the preceding.

## SPIRIFERINA, *D'Orbigny.*

### SPIRIFERINA NORWOODANA.

*Plate* 29, *Figs.* 16, 17.

*Spiriferina norwoodana*, HALL. Trans. Alb. Inst., vol. iv, p. 7. 1856.
*Spiriferina norwoodana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 48, pl. 6, figs. 16, 17. 1882.

Shell small, semi-elliptical, very gibbous, angles rounded; hinge line less than the greatest width of the shell. Ventral valve very convex and strongly arching near the beak, which is curved over the area; plications about eight, the central ones very strong, and the mesial depression distinctly continued to the beak. Dorsal valve ranging from depressed convex to extremely convex, and marked by three strong plications on each side of the mesial fold, which has often a depressing line along the center towards the base, with scarcely a distinct fold in the sinus of the ventral valve. Area small, high, not extending to the extremities of the hinge; foramen scarcely higher than wide; surface, in unworn specimens, marked by concentric, imbricating lamellæ.

Length, .07 to .18; width, .08 to .21 of an inch.

This species in its more perfect condition exhibits the plications extending very distinctly to the cardinal margin. In some specimens, the depression along the mesial fold is very marked, while in others it is scarcely visible. In some young shells which are apparently of the same species, the plications do not continue so well marked to the apex, while the wearing of the surface sometimes produces an apparent coalescing of the plications towards the beak.

*Localities.*—Alton, Ill.; Spergen Hill, Ind.

## ATHYRIS, *McCoy.*

### ATHYRIS HIRSUTA.

*Plate* 29, *Figs.* 18–21.

*Spirigera (Athyris) hirsuta*, HALL. Trans. Alb. Inst., vol. iv, p. 8. 1856.
*Athyris hirsuta* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 49, pl. 6, figs. 18-21. 1882.

Shell varying in form from ovate to sub-circular; beak prominent, slightly extended, front compressed, sometimes faintly sinuate. Valves nearly equally convex, the ventral valve most convex toward the beak; beak of ventral valve prominent, incurved so as to bring the minute foramen nearly on a line with the margin of the shell; beak of the smaller valve closely incurved beneath the beak of the opposite valve. Surface ornamented by concentric, imbricating lamellæ which give origin to successive rows of minute spines.

The cast shows faint impressions of radiating striæ, which are not visible on the external surface of the shell. A narrow, impressed line is sometimes shown down the center of the cast of the ventral valve; and a few specimens have a shallow, depressed groove down the center of the shell, from beak to base in both valves. A cast of a large individual shows about seven turns of the internal spire.

This shell in its young state is usually ovate, the broadest end being the front of the shell; the beaks are distinct and elevated, gradually tapering from the body of the valve. As the shell becomes older, it assumes a broader and more nearly circular form, and the beak becomes more elevated above the body of the shell than in the young state. The greater number of these shells have no trace of a sinus, but in some of the older specimens there is a slight depression in the larger valve, which produces a sinuosity in front. The minute spines appear to be produced by the splitting of the edges of the imbricating lamellæ. In some specimens the spines are very distinct near the border of the shell, but in worn individuals nothing remains but the fine, concentric lines.

From the foregoing description it will be seen that this species is closely related to the *Terebratula Roysii* of Leveille, and to *T. planosulcata* of Phillips. It differs from the first in its

small size and more ovate form, especially of young individuals, and in never having the distinct sinus possessed by that shell; while the beaks of our shell are more prominent and the slope on each side is less concave. The volutions of the internal spire in *A. hirsuta* are not more than half the number represented in *T. Roysii*. From the *T. planosulcata*, it differs in its smaller size, in being less ventricose, especially toward the front margin, in the proportionally more prominent beaks and generally more elongate form. From the specimens examined, the projecting spinose lamellæ in our shell are never so much extended as in that species. [Larger specimens of this species from Lanesville, Ind., indicate its near relation, if not identity, with *Athyris subquadrata*.]

*Localities.*—Alton, Ills.; Spergen Hill, Lanesville, and Bloomington, Ind.

### ATHYRIS TRINUCLEUS.

*Plate* 29, *Figs.* 22, 27.

*Terebratula trinucleus*, HALL. Trans. Alb. Inst., vol. 4, p. 7. 1856.
*Terebratula trinucleus*, HALL. Geol. Rept. Iowa, p. 659. 1858.
*Arthyris trinucleus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 50, pl. 6, figs. 22–27. 1882.

Shell sub-pentagonal or ovate, robust; trilobate lobes nearly equal, valves nearly equal, the ventral one gibbous toward the beak; a sinus in the center, beginning above the middle of the valve, gradually becoming wider and deeper toward the base, and some specimens distinctly bounded by an obtusely angular ridge. Dorsal valve varying from sub-circular to transversely oval and longitudinally ovate, most convex between the center and the beak, and distinctly trilobate, lobes extending about half way to the beak; the middle lobe often marked by a distinct linear depression; beak of ventral valve strong, rounded and incurved; truncated vertically by a distinct rounded foramen. Surface marked by fine concentric lines, which undulate with the lobes, and are extremely sinuous near the margin of the shell.

Old shells are often marked by strong imbricating lamellæ at unequal distances.

Length, .20 to .51; width, .19 to .26 of an inch.

This is a robust species, exhibiting some variations in form, but preserving sufficiently its distinctive characteristics to be recognized in all its forms and stages of growth. The trilobate character of the lower half of the shell is less distinct in the young individuals, but is always to be discerned. The longitudinally ovate forms are less distinctly trilobate near the base than the shorter ones. The strong imbricating lamellæ of growth are often visible near the margins of the valves in young shells, and become more conspicuous with age.

[Later collections, and particularly those of the Indiana Geological survey, furnish specimens of much larger proportions than those originally described, and in many of these the internal spires are well preserved, or are exposed in broken specimens, clearly proving its relations with Athyris.]

*Localities.*—Spergen Hill, Lanesville, Greencastle Junction, and Bloomington, Indiana.

## RHYNCHONELLA, *Fischer.*

### RHYNCHONELLA RICINULA.

*Plate 29, Fig. 46.*

*Rhynchonella ricinula*, HALL. Trans. Alb., Inst., vol. 4, p. 9. 1856.
*Rhynchonella ricinula*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 53, pl. 6, fig. 46. 1882.

Shell very small, longitudinally ovate or sub-lenticular, neatly rounded in front; valves almost equally convex; beak of ventral valve straight, comparatively much extended, perforate by a triangular foramen; surface marked by from twelve to sixteen angular plications, which often terminate abruptly about one-third of the distance from base to beak, sometimes becoming obsolete on the upper half of the shell.

Length, .11; width, .10 of an inch.

This shell bears a close resemblance to *R.* (*atrypa*) *nana*, of McCoy (Carb. Foss. of Ireland, p. 655, pl. 22, fig. 19), but our shell is smaller, and has from two to six plications or more on each valve. In many specimens the plications are strong on the margin, and terminate abruptly on the lower third of the shell, while in others they are faintly visible on the upper half. It is possible that the presence or absence of the plications is,

in some degree, affected by wearing or maceration. With a larger number of specimens for comparison, this shell might be found identical with Professor McCoy's species.

Thus far I have not found gradations from this to larger forms, but it is still possible that this form may prove to be a young shell.

*Locality.*—Spergen Hill and Lanesville, Indiana.

### RHYNCHONELLA GROSVENORI.

*Plate* 29, *Figs.* 31–34.

*Rhynchonella grosvenori*, HALL. Trans. Alb. Inst., vol. iv, p. 10. 1856.
*Rhynchonella grosvenori*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 53, pl. 6, figs. 31–34. 1882.

Shell globose or sub-triangular, rotund or depressed; dorsal valve more convex than the other; greatest convexity of the two valves near the front, sloping abruptly toward the beak, where the two sides meet at nearly a right angle; beak of the ventral valve rather small, neatly defined, nearly straight or slightly incurved, with a linear or sub-triangular foramen, beak of opposite valve round and obtuse, closely incurved; surface marked by from fourteen to eighteen distinct, rounded, simple plications, which often become obsolete toward the beaks; four or five of the folds depressed, forming a sinus on the larger valve, with a corresponding elevation of five or six plications on the opposite valve.

Length, .14 to .22; width, .13 to .23 of an inch.

This species is one of a very numerous group, of which *R. Wilsoni* may be considered as the typical form, and it becomes very difficult to give such characters as will serve to distinguish it from all others of the same group. The young shells are ovate-depressed, the margins presenting no appearance of a sinus. As the shell increases in size it becomes more rotund, the sinus in the margin becomes gradually indicated, and finally the shell assumes an almost globular form, with the small triangular beak projecting above, and the plications in the sinus greatly elevated.

*Localities.*—Alton, Ill.; Spergen Hill, and Bloomington, Ind.

## RHYNCHONELLA MUTATA.

*Plate* 29, *Figs.* 43–45.

*Rhynchonella mutata*, HALL. Trans. Alb. Inst., vol. iv, p. 10. 1856.
*Rhynchonella mutata*, HALL. Geol. Rep. Iowa, p. 658, pl. 23, fig. 2. 1858.
*Rhynchonella mutata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 52, pl. 6, figs. 43–45. 1882.

Shell sub-trigonal, more or less gibbous, front broadly rounded or nearly straight, abruptly tapering to the apex, the two sides meeting at an angle of nearly 90°; dorsal valve much more convex than the opposite one, which is often depressed; shell most convex near the anterior margin; beak of ventral valve nearly straight, or but slightly incurved; foramen triangular; beak of the opposite valve obtusely angular and closely incurved against the ventral valve; surface marked by from twelve to sixteen strong sub-angular plications, about four or five of which are depressed in the sinus of the ventral valve; sinus not deeply impressed on the margins of the shell; concentric striæ rarely visible.

Length, .15 to .30; width, .14 to .32 of an inch.

This shell strongly resembles *R. grosvenori* in some of its varieties; but the shell is larger and more coarsely and strongly plicated, more angular in its outline, generally broader across the base, and having, in some of its varieties, the form of an equilateral triangle. Some specimens which appear to be identical with this species are very much compressed and sharp on the anterior margin, with a scarcely distinct sinus, while others are very gibbous and extremely obtuse along the front margin. In a few instances strong concentric striæ are visible, and it is probable that all the specimens were originally marked by similar fine concentric lines. It is a variable species, presenting few exclusive characters.

*Localities.*—Alton, Ills.; Spergen Hill, and Lanesville, Ind.

## RHYNCHONELLA SUBCUNEATA.

*Plate* 29, *Figs.* 47–49.

*Rhynchonella subcuneata*, HALL. Trans. Alb. Inst., vol. iv, p. 11. 1856.
*Rhynchonella subcuneata*, HALL. Geol. Rept. Iowa, p. 658, pl. 23, fig. 3. 1858.
*Rhynchonella subcuneata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 51, pl. 6, figs. 47–49. 1882.

Triangular, sub-cuneate; front rounded, meeting the lateral slopes at an obtuse angle; sides sloping to the beak and meeting at an angle of 60° or 65°; valves nearly equally convex, ventral valve most convex toward the beak; beak of ventral valve very acute, scarcely incurved, and perforate by a triangular foramen; dorsal beak of valve acute, closely incurved below the triangular foramen. Surface marked by about twelve to fourteen (and rarely sixteen) strong, simple, angular plications, which are somewhat obsolete near the beak; scarcely any indications of a sinus; plications crossed by fine concentric striæ, and in old shells, at irregular distances, by stronger imbricating folds or wrinkles parallel to the lines of growth; sides of both valves beneath the beak free from plications, and forming a very distinct elongate-oval space.

Length, .16 to .41; width, .15 to .39 of an inch.

This is a well marked species, quite distinct from either of the preceding, and distinguished by its elongate triangular form and the long oval concave space on each side below the beaks, which is limited on both valves by a distinct angular margin. In young individuals the shell is very flat, especially toward the front, but it becomes more convex and sometimes extremely gibbous with age. This species resembles *R. cuneata*, from which it is distinguished by the more numerous plications and shorter form. In the plain concave elliptical areas on each side below the beaks, it resembles the *R.* (*Terebratula*) *trilatera* of De Koninck, according to his description; while the sinus in both valves of that species, as well as other characters, are quite distinctive.

*Localities.*—Bloomington, Lanesville, and Spergen Hill, Ind.

### RHYNCHONELLA MACRA.

*Plate* 29, *Figs.* 40–42.

*Rhynchonella macra*, HALL. Trans. Alb. Inst., vol. iv, p. 11. 1856.
*Rhynchonella macra*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 52, pl. 6, figs. 40–42. 1882.

Shell triangular, flattened; apex acute; valves nearly equal; the ventral valve a little more convex towards the beak, which is quite straight, extended beyond the lesser valve, and with a sub-triangular foramen which is slightly rounded above. Surface marked by from eighteen to twenty-four small rounded plications which are about equal to the spaces between.

Length, .15 to .24; width, .14 to .29 of an inch.

This shell is always compressed and extremely thin toward the front, attaining only a moderate convexity near the beaks. The young shells bear some resemblance to the young of *R. subcuneata*, but may always be distinguished by the greater number of plications, a more compressed form, and an absence of the flattened or concave areas on each side below the beaks. The front of the shell is usually straight, but in old shells it is sometimes slightly undulating, the depression being always in the dorsal valve.

*Locality.*—Lanesville, Ind., and Alton, Ill.

## CAMAROPHORIA, *King.*

### CAMAROPHORIA [?] WORTHENI.

*Plate* 29, *Figs.* 35–39.

*Rhynchonella wortheni*, HALL. Trans. Alb. Inst., vol. iv, p. 11. 1856.
*Camarophoria wortheni*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 54, pl. 6, figs. 35–39.

Shell small, longitudinally sub-trigonal, very abruptly tapering to the apex; dorsal valve very convex or gibbous towards the front; ventral valve nearly flat and broadly sinuate in front, with a single broad flattened plication, commencing near the margin, and filling a deep sinus in the opposite valve, corresponding to two short rounded plications on the front of the dorsal valve; edge of the shell on each side of the mesial sinus sharply undulated, with indistinct marginal folds. Beak of

the ventral valve pointed, straight, with a triangular foramen. Surface marked by fine concentric striæ, and some faint remains of finer radiating striæ.

Length, .26; width .24 of an inch.

This species apparently belongs to the same group as *R. acuminata*, *R. pugnus*, etc. It differs from the young plicated varieties of *R. acuminata* in the flatter ventral valve, more trigonal form, and straight beak. There are one or two other forms in the Chemung group and Carboniferous limestone not widely removed from this form. The species belongs to a group which is subject to much variation, and it is probable that we shall find other individuals differing in the number and strength of the plications.

*Locality.*—Alton, Ill.

## EUMETRIA, *Hall.*

### EUMETRIA VERNEUILIANA.

*Plate* 29, *Figs.* 28–30.

*Retzia verneuiliana*, HALL. Trans. Alb. Inst., vol. iv, p. 9. 1856.
*Retzia verneuiliana*, HALL. Geol. Rept. Iowa, p. 657, pl. 23, fig. 1. 1858.
*Eumetria verneuiliana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 50, pl. 6, figs. 28–30. 1882.

Shell longitudinally ovate; valves almost equally convex, ventral valve most prominent near the beak, which is elevated and incurved so as to bring the circular foramen nearly on a line with the margins of the valves; foramen round. The dorsal valve smaller, auriculated on the cardinal angles, beak small, scarcely rising above the straight cardinal margin; area small, triangular, not entirely confined to the larger valve, bounded by a distinct angular margin. Surface longitudinally striate, marked by about fifty rounded, beautifully punctate, simple striæ.

Length, .10 to .32; width, .08 to .27 of an inch, usually; some specimens have a length of three-fourths of an inch.

This is a neat, beautiful little species, uniformly marked by simple rounded striæ, the valves nearly equally convex (except near the beak of the larger valve), without any trace of a sinus. The form is usually rotund, but sometimes flattened towards the

front. The cardinal line of the smaller (dorsal) valve is extended on each side, giving it much the appearance (when seen alone) of a small pecten. In well preserved specimens the area is very distinct and sharply defined. The punctæ are only visible under a good defining glass.

The nearest analogies are with *Retzia* (*Terebratula*) *Marcyi* [=EUMETRIA] of Shumard, (Marcy's Rept. on the Exp. of Red river of Louisiana, p. 203, pl. 1, fig. 4), and with *R.* (*terebratula*) *serpentina* [=EUMETRIA] of de Koninck (Carb. Fossils Belgium, p. 291, pl. 19, fig. 8), Woodward, Davidson, etc. It differs from the former in having a greater number of striæ and more elongate form, while the specimens are usually much smaller. Its geological position is very different, the *R. marcyi*, which occurs in the limestone of the coal measures, while the present species lies far beneath the coal. From *R. serpentina* it differs in its much smaller size and more numerous striæ which are always simple, while the beak of the larger valve is not so large and wide as represented in the figures of *R. serpentina*.

If, as stated by de Koninck, *terebratula serpentina* is not auriculate, this character in *R. verneuiliana* is sufficient to distinguish it.

There is a much larger species with stronger radii, occurring in the Kaskaska limestone, which I have seen in collections labeled *T. serpentina*.* In that shell the radii are fewer and the smaller valve is less distinctly auriculate at the cardinal angles.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## TEREBRATULA, *Lhwyd.*

### TEREBRATULA TURGIDA.

*Plate* 29, *Figs.* 53–58.

*Terebratula turgida*, HALL. Trans. Alb. Inst., vol. iv, p. 6. 1856.
*Terebratula turgida*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 54, pl. 6, figs. 53–58.

Shell longitudinally ovate, often extremely gibbous, emarginate in front; ventral valve most convex in the middle,

* This species is the *Retzia vera* of the Iowa Geological Report=*Eumetria vera*.

having a sinus extending to the base of the shell; umbo large, rounded and prominent; beak incurved and pointed, with an oval or sub-circular foramen just above, or in the extremity; dorsal valve most convex in the middle or near the front, with or without a short sinus, in which is sometimes a short and obscure fold. Surface marked by strong concentric lines of growth, and near the front, in some shells, are strong wrinkles or folds which distort the form of the shell.

Length, .16 to .32; width, .13 to .27 of an inch.

This shell has its nearest affinities with *T. sacculus*, but differs in being much more gibbous in old shells and narrower, the depth being often greater than the width; the beak of the ventral valve is comparatively larger and more rounded. From *T. hastata* it differs equally in these respects, and still more in its much smaller size.

In young shells of this species the form is oval or ovoid, the valves moderately convex, and flattened toward the front, which may or may not present the emarginate character, both valves being sometimes without a sinus. As the shell becomes older it acquires a more gibbous form, and sometimes becomes extremely turgid, the surface being concentrically contracted and expanded at intervals by irregular growth. The sinuosities of one or both valves are often developed in the young state, producing the emarginate front, and, rarely, the fold in the sinus of the dorsal valve. Surface finely punctate.

*Localities.*—Alton, Ills.; Bloomington, Lanesville, and Spergen Hill, Ind.

### TEREBRATULA FORMOSA.

*Plate* 29, *Figs.* 59–64.

*Terebratula formosa*, HALL. Trans. Alb. Inst., vol. iv, p. 6. 1856.
*Terebratula formosa*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 35, pl. 6, figs. 59–64. 1882.

Shell longitudinally oval-ovate; ventral valve more convex in the middle and upper part; beak extended upwards, prominent, incurved; valves compressed near the front, which is neatly rounded, the margin presenting a slight undulation; sometimes sinuate in front; surface marked by fine concentric lines of

growth, and sometimes by stronger parallel folds or wrinkles. Under the magnifier the shell presents a finely punctate structure.

Length, .14 to .44; width, .10 to .31 of an inch.

In the typical forms of this species the valves are symmetrically convex, sloping gradually to the front, where there is sometimes a slight undulation in the outline of the edges. In some specimens there is a depression in the ventral valve, near the lower part, producing a straightening, or even a slight emargination in front. In this respect it has some analogy with *T. hastata*, but the dorsal valve is never depressed, and the front is proportionally narrower. In the young of this species and of *T. turgida* there is a similarity in some specimens, but the older shells show a well marked distinction. This species attains a much larger size than any of our specimens of *T. turgida*.

*Localities.*—Alton, Ill.; Bloomington, Lanesville and Spergen Hill, Ind.

## LAMELLIBRANCHIATA.

### CYPRICARDELLA, *Hall.*

Shell ovate or sub-elliptical, and sub-quadrate (sub-equilateral), closed; surface concentrically striated, hinge of right valve having two cardinal teeth; the anterior tooth directly beneath the beaks, somewhat strong, triangular; posterior tooth more slender, and turned obliquely backwards, leaving a triangular pit, which is probably occupied by a tooth in the other valve; anterior cardinal margin with a long, narrow groove, apparently for the reception of a slender projection of the other valve; posterior side beveled from above, edge thin, ligament external, occupying a deep cavity; muscular impressions distinct, shallow; pallial impression simple.

In form and external characters these shells resemble the genus MICRODON, of Conrad, but we do not know fully the characters of the hinge of that genus. Since the interior of only a single valve has been observed, it might be premature to attempt to assign to this genus its true place.

This genus includes a small group of shells usually referred to *Cypricardia*, but, in their external and internal characters,

they are unlike, differing from *Cypricardia* in having only two cardinal teeth. Our shells have the form and external markings of *Nucula rectangulosis* of McCoy, which is referred by D'Orbigny in his Prodrome to *Cypricardia*.

It seems necessary to construct a genus of these species marked by fine, regular, concentric lines and broad posterior extremity, which is usually more or less truncate, since we know from external characters alone that they are not correctly referred to *Cypricardia*.

### CYPRICARDELLA SUBELLIPTICA.

*Plate* 30, *Figs.* 27–29.

*Cypricardella subelliptica*, HALL. Trans. Alb. Inst., vol. iv, p. 17. 1856.
*Microdon* (*Cypricardella*) *subelliptica*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 64, pl. 7, figs. 27–29. 1882.

Shell sub-elliptical obliquely truncated at the posterior end; beaks minute at the apex, rising a little above the hinge; umbones sub-gibbous, with an undefined elevation extending obliquely toward the posterior basal margin; anterior end narrower than the posterior, rounded at the extremity. Cardinal margins forming an angle with the beak of 25°; base forming a regular elliptical curve. Surface marked by regular, fine, concentric, elevated lines which are equal to the spaces between.

Length, .19 to .32; width, .14 to 24 of an inch.

*Locality.*—Spergen Hill, Ind.

### CYPRICARDELLA NUCLEATA.

*Plate* 30, *Figs.* 35, 36.

*Cypricardella nucleata*, HALL. Trans. Alb. Inst., vol. iv, p. 17. 1856.
*Cypricardella nucleata*, HALL. Geol. Rept. Iowa, p. 664, pl. 23, fig. 10? 1858.
*Microdon* (*Cypricardella*) *nucleata* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 64, pl. 7, figs. 35, 36. 1882.

Shell inequilateral, sub-quadrangular, gibbous; anterior end short, rounded; posterior end broader, abruptly compressed, vertically truncated at the extremity; beak nearer the anterior end, small; posterior umbonal slope extremely gibbous (a

broad undefined ridge) reaching to the base of the truncation. Surface marked by fine regular concentric lines parallel to the border of the shell.

Length, .11 to .13; width, .08 to .10 of an inch.

This species is much smaller and less nearly equilateral than the preceding, with a more gibbous umbonal region. The posterior end is abruptly truncate, the truncation slopes upward and outward from the base. In this respect it is the reverse of *C. subelliptica*, which is more elliptical and obliquely truncated, the truncation not reaching to the base. It is closely related in form to *Nucula rectangularis* of McCoy.

*Locality.*—Spergen Hill, and Lanesville, Ind.

### CYPRICARDELLA OBLONGA.

*Plate* 30, *Figs.* 30–34.

*Cypricardella oblonga*, HALL. Trans. Alb. Inst., vol. iv, p. 18. 1856.
*Microdon* (*Cypricardella*) *oblonga* (Hall, sp.). Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 65, pl. 7, figs. 30–34. 1882.

Shell oblong, sub-quadrangular; anterior end, narrow, rounded; posterior end broader, flattened, and almost vertically truncate; cardinal margin nearly straight and horizontal behind, declining in front; base nearly parallel to the hinge-line; beaks small, somewhat prominent, gibbous below; posterior umbonal slope gibbous or sub-angular, and extending obliquely downward and backward to the base of the truncation; lunule small, ovate, deep in the center; escutcheon linear distinct.

Length, .09 to .30; width, .06 to .20 of an inch.

This species, in some of its characters, is intermediate between *C. subelliptica* and *C. nucleata;* it is much less elliptical than the first, with the beaks more nearly anterior and more distinctly truncated; and it is much longer than the last, less expanded behind and less gibbous. The posterior truncation slopes downward and outward, and the hinge-line is straighter than in either of the others. We have specimens from the extremely young to the length of half an inch, showing in all stages a constant form which readily enables one to distinguish this form from either of the other species.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### SANGUINOLITES? (GONIOPHORA??) PLICATA.

*Plate* 30, *Fig.* 39.

*Cypricardella plicata*, HALL. Trans. Alb. Inst., vol. iv, p. 18. 1856.
*Goniophora plicata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 66, pl. 7, fig. 39. 1882.

Shell oblong, sub-quadrate, hinge line slightly arched, the base and hinge-line nearly parallel; gibbous in the middle above, and anteriorly depressed in the middle toward the base; beaks near the anterior end small and scarcely rising above the hinge margin; anterior end short, scarcely extending beyond the beak, and rounded; posterior extremity doubly truncate, a strong fold or angulation extending from the umbo to the posterior basal margin, and a smaller similar fold midway between that and the hinge-line, the intervals between these being truncate. Surface marked with concentric lines of growth.

Length, .12; width, .12 of an inch.

This species is characterized by the two folds or angulations on the posterior slope, giving a double truncation; the upper one, from the hinge to the first fold, slopes outward, while that from the first to the second fold slopes toward the base, making the greatest extension of the shell an obtuse angle at the upper fold. These folds are continued nearly to the beak of the shell. The lower part of the shell, near the middle of its length, is slightly depressed, but this depression scarcely reaches the margin.

A specimen from Spergen Hill shows plications on the posterior slope. So far as can be determined at present this specimen is only a variety of *C. plicata*. The generic relations of this shell have not been determined. [This shell is not congeneric with the preceding, and if the hinge be not crenulate, it is more nearly allied with Sanguinolites or Pleurophorus, but is not properly a Goniophora.]

*Locality.*—Spergen Hill, Bloomington and Lanesville, Ind.

## CYPRICARDINIA, *Hall.*

### CYPRICARDINIA INDIANENSIS.

*Plate* 30, *Figs.* 10–14.

*Cypricardia Indianensis*, HALL. Trans. Alb. Inst., vol. iv, p. 18. 1856.
*Cypricardinia (?) Indianensis*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 58, pl. 7, figs. 10–14. 1882.

Shell elongate-ovate, narrow and rounded in front; posterior end broader, compressed and sub-alate; base broadly curved; hinge line straight, less than the greatest length of the shell; a line or groove on the inner margin extending from the beak to the posterior extremity; beaks very small, near the anterior end; umbonal region gibbous. Surface marked by distinct, regular, imbricating lamellæ.

Length, from one-eighth to one-fourth of an inch.

This species in general aspect is not unlike several others, occurring in different positions in Silurian and Devonian rocks. A comparison of specimens, however, shows them to be distinct. The gibbous umbonal region, elongate-posterior side, and strong, undulating concentric laminæ are distinguishing features.

[The generic relations of this shell have not been satisfactorily determined.]

*Localities.*—Alton, Ill.; Spergen Hill, Bloomington, and Lanesville, Ind.

### EDMONDIA [??] SUBPLANA.

*Plate* 30, *Fig.* 38.

*Cypricardia subplana*, HALL. Trans. Alb. Inst., vol. iv, p. 19. 1856.
*Edmondia subplana*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 66, pl. 7, fig. 38. 1882.

Shell ovate oblong; anterior end very short; posterior end extremely elongate, very gradually narrowing to the extremity which forms a symmetrical elliptic curve; cardinal and basal margins nearly parallel; beaks small; umbonal region depressed convex. A few obsolete concentric folds visible on the surface; intermediate portions probably finely striate.

Length, .69; width, .38 of an inch.

This differs conspicuously from the preceding in its form, which gradually narrows behind with no indication of expansion toward the hinge line. The umbonal slope is somewhat depressed convex, and the whole shell has a flattened appearance. The surface markings have been nearly obliterated by wearing.

[The generic relations of this shell have not been satisfactorily determined. It does not belong to the genus *Cypricardia* as we now know, and is too unlike the typical forms of *Edmondia* to be placed under that genus, except with extreme reservation.]

*Locality.*—Spergen Hill and Lanesville, Ind.

## NUCULA, *Lamarck.*

### NUCULA SHUMARDANA.

*Plate* 30, *Figs.* 2–6.

*Nucula shumardana*, HALL. Trans. Alb. Inst., vol. iv, p. 16. 1856.
*Nucula shumardana*, HALL. Whitfield: Bulletin 3, Am. Mus. Nat. Hist., p. 57, pl. 7, figs. 2–6.

Shell obliquely ovate or sub-cuneate, gibbous toward the beaks; beaks anterior, elevated, approximate, or in contact; anterior end vertically truncate; posterior side cuneate, sloping from the beak; cardinal line forming an angle of about 80° at the beak; base forming a broad curve from the anterior and posterior cardinal margins; surface marked by regular equidistant, sub-imbricating striæ, rarely with unequal concentric folds; hinge-line somewhat strongly crenulate; ligamentary pit distinct, triangular.

Length, .09 to .21; width, .08 to .17 of an inch.

This is a pretty and neat species, distinguished by an obtuse anterior extremity, which forms less than a right angle with the posterior cardinal margin. The shell is gibbous toward the beak, abruptly rounded in front, and sloping toward the posterior extremity.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## LEDA, *Schumacher.*

### LEDA NASUTA.

*Plate* 30, *Figs.* 7–9.

*Nucula nasuta*, HALL. Trans. Alb. Inst., vol. iv, p. 17. 1856.
*Nuculana nasuta*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 57, pl. 7, figs. 7–9. 1882.

Shell sub-ovate, abruptly contracted behind; anterior extremity rounded; beaks prominent, sub-central; posterior side shorter and contracted, both laterally and vertically into a proboscidial extension; surface marked by regular lines of growth.

Length, .14; width, .09 of an inch.

*Localities.*—Spergen Hill and Lanesville, Ind.

## CONOCARDIUM, *Bronn.*

### CONOCARDIUM CATASTOMUM.

*Plate* 30, *Figs.* 15–17.

*Conocardium catastomum*, HALL. Trans. Alb. Inst., vol. iv, p. 13. 1856.
*Conocardium catastomum*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 58, pl. 7, figs. 15–17. 1882.

Shell very small, elongate, sub-cylindrical or sub-clavate, gibbous in the middle; beaks minute, rising slightly above the hinge-line, and anchylosed; anterior end obliquely truncated and obtusely angular on the umbonal slope; the anterior tubular wing minute; posterior end much extended, and constricted near the middle, swelling at the extremity and gaping below; surface marked with small, simple, radiating folds, which sometimes become obsolete on the anterior end and umbones; minute, undulating, concentric striæ cross the radiating folds in well preserved specimens.

Length, from 125 to .20 of an inch.

This species is readily distinguished by its elongate form and minute size (varying from one-eighth to one-quarter of an inch in length), its gibbous anterior end, and the constriction near the middle of the posterior half of the shell. The posterior extremity becomes suddenly expanded or tumid behind the constriction, and presents a comparatively large ovate hiatus below.

*Localities.*—Spergen Hill and Lanesville, Ind.

### CONOCARDIUM CARINATUM.

*Plate* 30, *Figs.* 18, 19.

*Conocardium carinatum*, HALL. Trans. Alb. Inst., vol. iv, p. 14. 1856.
*Conocardium carinatum*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 59, pl. 7, figs. 18, 19. 1882.

Shell sub-trigonal, gibbous in the middle, anterior end cordate; hinge line straight; beaks very small, strongly incurved, rising little above the hinge line; posterior side straight above, sloping upwards from below, and gradually tapering to the extremity, faintly constricted at its junction with the body of the shell and gaping below; hiatus elongate lanceolate, crenulate; umbonal slope strongly carinated; carina reaching from beak to base, where it is strongly salient; anterior side obliquely truncate, and abruptly produced into a small conical tubular extension of the hinge-line. Surface marked by simple radiating ribs, and extremely fine concentric striæ, which, in passing over the ribs give the surface a granulated appearance. On the anterior slope the ribs are finer and closer than on the sides of the shell, and strongly curved.

Length, from .20 to .33 of an inch.

This species is distinguished from the others described by the strong carina, which becomes alate on the lower part of the shell, from the abrupt slope of the base of the posterior side and narrow elongate hiatus. In unworn specimens, the fine concentric lines in crossing the ribs, produce minute granulations, which are seen only with a good lens. The anterior extremity of the shell is broadly cordate with a minute conical wing above; some of the ribs, which are distinct near the base, coalesce with the carina before reaching the beak.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### CONOCARDIUM CUNEATUM.

*Plate* 30, *Figs.* 24–26.

*Conocardium cuneatum*, HALL. Trans. Alb. Inst., vol. iv, p. 14. 1856.
*Conocardium cuneatum*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 60, pl. 7, figs. 24–26. 1882.

Shell sub-trigonal or abruptly clavate; hinge-line straight; beaks anchylosed, incurved, very small, rising but little above

the hinge-line; umbonal slope angular; anterior side truncate, concave just within the angle of the umbonal slope, convex in the middle, and abruptly produced above, in continuation of the hinge-line, into a tubular wing; posterior side vertically compressed, straight along the hinge-line, and abruptly declining at the extremity, sloping along the base from the center of the shell to the extremity. Hiatus elongate, extending forward to near the middle of the shell, rounded and expanded at the posterior extremity, and deeply crenulate in the margins of the narrower part. Surface marked by distinct radiating costæ, which often alternate in size or bifurcate on the posterior part of the shell, crossed by fine elevated concentric lines of growth, more or less closely arranged. Near the basal margin are some stronger sub-imbricating ridges parallel to the lines of growth.

Length, .33 to .50 of an inch.

This shell resembles C. carinatum, but it is larger and proportionally thicker, the ribs are less distinctly angular on the anterior umbonal slope, and less regular, especially on the posterior side of the shell, just behind the more gibbous part, where they often bifurcate or alternate in size; also, the concentric lines are stronger, and there is no evidence of granulations at the crossing of the radiating and concentric lines. The shell is remarkable as being vertically compressed or pinched toward the posterior extremity, where the sudden declination of the cardinal margin gives it an abrupt wedge-shaped termination. The cardinal margins are distinctly anchylosed and the posterior edge of the hiatus at the junction of the two valves is distinctly continuous.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### CONOCARDIUM PRATTENANUM.

*Plate* 30, *Fig.* 20.

*Conocardium prattenanum*, HALL. Trans. Alb. Inst., vol. iv, p. 85. 1856.
*Conocardium prattenanum*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 61, pl. 7, fig. 20. 1882.

Shell sub-fusiform; hinge-line straight, beaks depressed, distinctly anchylosed; from the beaks along the anterior umbonal slope the angle is obtuse and scarcely defined; anterior

side obtuse, convex in the middle, and gradually sloping upward from the angles; posterior part of the shell with a broad depression on each side, and again expanding at the extremity with an oblique angular fold, from the hinge-line downward to the hiatus; hiatus broad and expanded behind, narrowed abruptly at the junction of the oblique folds, and thence gradually to the middle of the shell. Surface marked by strong plications, which are much stronger on the anterior part of the shell, and more slender behind. The fold along the anterior umbonal slope bifurcates, sending off on each side a plication, which again bifurcates. Plications crossed by sharply elevated lines, which are more conspicuous on the posterior part, give it a cancellated appearance.

Length, .20 of an inch.

This species differs from either of the preceding in the greater prominence of the anterior end, which is likewise more strongly costate. The angle of the umbonal slope is less prominent, and it differs conspicuously from either of the others in the bifurcation of the folds. The ribs on the posterior slope are smaller than on the anterior side; in this respect being the reverse of the other species; the cancellating lines are nearly as strong as the ribs on the posterior end. The strong angles projecting from the hinge-line to the hiatus are also a marked character. The hiatus of this species is proportionally more extended forward than in any of the preceding, and does not contract so rapidly in that direction.

*Locality.*—Alton, Ills.

### CONOCARDIUM MEEKANUM.

*Plate* 30, *Figs.* 21–23.

*Conocardium meekanum*, HALL. Trans. Alb. Inst., vol. iv, p. 15. 1856.
*Conocardium meekanum*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 61, pl. 7, figs. 21–23. 1882.

Shell sub-angularly ovate or abruptly clavate; hinge line nearly straight, declining at the posterior extremity and sometimes from the beaks, obliquely truncated anteriorly; anterior end convex in the middle, and margined by a narrow sulcus which reaches from beak to base, just within the obtuse angle

of the umbonal slope; posterior end sloping on the base uniformly from the center of the shell to the extremity, contracted behind the body of the shell; vertically depressed and slightly expanded laterally at the extremity. Surface marked by small elevated thread-like radiating lines, which on the posterior part of the shell are crossed by finer concentric striæ, giving that part of the shell a cancellated appearance. Anterior end depressed, marked by much fainter radiating lines crossed by nearly obsolete traces of fine striæ, which converge toward the anterior tubular wing.

Length, .20 to .33 of an inch.

This shell bears the nearest relation to *C. cuneatum*, but differs in being smaller, the umbonal slope is more rounded, and the radiating lines on the anterior end are much less strong, and this part of the shell is margined by a distinct groove or sulcus. On the body and the posterior part of the shell the radiating striæ are finer than in *C. cuneatum*, but, like that, are sometimes bifurcating.

*Locality.*—Alton, Ill.

### CONOCARDIUM EQUILATERALE.

*Conocardium equilaterale*, HALL. Trans. Alb. Inst., vol. iv, p. 16. 1856.
*Conocardium equilaterale*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 62, 1882.

Shell triangular, sub-equilateral, scarcely gibbous in the middle; hinge-line very straight; beaks small, rising a little above the hinge-line; anterior end cuneate, sloping gradually from near the center of the shell; umbonal ridge obtuse above, nearly at right angles to the hinge, and subdividing several times before reaching the base; posterior end cuneate, very gradually sloping from the body of the shell; extremity unknown; surface marked by radiating striæ or folds, which are simple or bifurcating, and crossed by fine, regular, elevated, thread-like lines.

Length and width nearly equal, about .125 of an inch.

This shell is very different from the other species, in the thin wedge-form anterior end, which slopes upward, gradually, from the base. There is no tubular anterior wing visible. The

nearly equilateral form, slight gibbosity in the middle, rectangular direction of the angle of the umbonal slope, which is subdivided into several striæ or plications before reaching the base, are very distinctive characters.

The specimen described is deficient in the posterior extremity, and the form of the hiatus is unknown.

*Locality.*—Spergen Hill, Ind.

## GASTEROPODA.

### EUOMPHALUS, *Sowerby.*

#### EUOMPHALUS QUADRIVOLVIS.

*Plate* 31, *Figs.* 24, 25.

*Euomphalus quadrivolvis*, HALL. Trans. Alb. Inst., vol. iv, p. 19. 1856.
*Straparollus quadrivolvis*, HALL. S. A. Miller; Cat. Am. Pal. Foss. 1877.
*Euomphalus quadrivolvis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 71, pl. 8, figs. 24, 25. 1882.

Shell planorbicular, spire depressed, composed of about four turns, the inner one scarcely rising above the last volution; volutions somewhat rapidly increasing from the apex, regularly rounded; aperture round-oval, slightly transverse; umbilicus less than the diameter of the outer volution; surface marked by fine, closely-arranged striæ of growth.

Diameter, .12 to .31; elevation, .06 to .16 of an inch.

This shell is distinguished by the depressed spire, showing in profile only the second volution. The volutions are regularly rounded, never angular above or below. The umbilicus is comparatively small, the volutions increasing rapidly in size. The surface is marked by regular striæ of growth, which may be occasionally irregular from accident to the shell in its growing condition.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## EUOMPHALUS SPERGENENSIS.

*Plate* 31, *Figs.* 16, 19.

*Euomphalus Spergenensis*, HALL. Trans. Alb. Inst., vol. iv, p. 19. 1856.
*Straparollus Spergenensis*, HALL. S. A. Miller; Cat. Am. Pal. Fossils. 1877.
*Euomphalus Spergenensis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 69, pl. 8, figs. 16–19. 1882.

Shell sub-discoid or planorbiform; spire composed of five or six turns, the inner ones coiled in the same plane, two or three of the outer ones only visible in profile; suture well defined on both sides; volutions rounded below with a distinct obtuse angulation on the upper side, a little distance from the suture; umbilicus nearly twice the breadth of the outer volution; aperture oblique, round-oval with a slight expansion at the angle on the upper side of the volution. Surface marked by close, fine, equal striæ of growth.

Diameter, .30 to .1 inch; height, .23 to .25 of an inch.

This shell resembles the *E. lævis* of D'Archiac and De Verneuil. (Trans. Geol. Soc. Lond., vol. vi, 2d series, part 2, page 363, plate 33, fig. 7.) *E. planorbis*, in part of De Koninck. (Carb. Fossils of Belgium, page 434, plate 25, fig. 7.)

Our shell agrees with the description of MM. D'A. and De V.; with the exception of the form of the aperture. The figures given by these authors show the greatest diameter of the aperture to be transverse, while in the species here described the longest diameter is obliquely outward and downward from the axis of the shell.

Our shells with five turns of the spire are much smaller than *E. lævis* of these authors, and our larger specimens are precisely of the same size as the four inner volutions of their figures.

It is possible, however, that these deviations which appear constant in our specimens may prove to be only a variety not of specific value. Our specimens of this species, which are numerous, do not lead us to include the *E. planorbis* of D'A. and De V. as a variety.

Our specimens present all gradations, from those with the spire entirely flat to those where the three outer volutions are visible in profile. In all these the obtuse angulation on the upper side of the volution is present.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### EUOMPHALUS SPERGENENSIS, var. PLANORBIFORMIS.

*Plate* 31, *Figs.* 20, 21.

*Euomphalus Spergenensis*, var. *planorbiformis*, HALL. Trans. Alb. Inst., vol. iv, p. 20. 1856.

*Straparollus Spergenensis*, var. *planorbiformis*, HALL. S. A. Miller; Cat. Am. Pal. Fos. 1877.

*Euomphalus Spergenensis*, var. *planorbiformis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 70, pl. 8, figs. 20, 21. 1882.

Shell discoid; spire flat or concave; volutions about four, rounded above and below; aperture nearly circular; umbilicus broad, not deep.

This variety differs from the flattened forms of the species in the absence, or only slight indication, of the angulation on the upper side of the volution. The spire is often concave, and in such specimens there is an obtuse angulation on the upper side of the volution, but differing so much from the last described as to present a distinction from the same feature in those of the species with raised spires. The size and form of the volutions, and their ratio of increasing size, correspond with characteristic features of the species.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### EUOMPHALUS PLANISPIRA.

*Plate* 31, *Figs.* 22, 23.

*Euomphalus planispira*, HALL. Trans. Alb. Inst., vol. iv, p. 20. 1856.

*Straparollus planispira*, HALL. S. A. Miller; Cat. Am. Pal. Fossils. 1877.

*Euomphalus planispira*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 70, pl. 8, figs. 22, 23. 1882.

Shell discoid; spire flat or scarcely concave; volutions about five or six, slender, very gradually increasing in size, rounded above and below; suture well defined; aperture circular; umbilicus broad and shallow. Surface marked by fine, closely arranged and slightly undulating striæ.

Diameter, .36; height, .12 of an inch.

This shell is distinguished from either of the preceding by its slender volutions, which increase much more gradually from the apex. The volutions are round, both above and below,

though sometimes the lower side descends so abruptly to the umbilicus as to present the appearance of an obtuse or undefined angle on the last volution.

The broad and shallow umbilicus of this species results from the flatness of the spire and the small diameter of the volutions. The volutions are as perfectly distinguishable on the lower as on the upper side of the shell.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## PLEUROTOMARIA, *DeFrance.*

### PLEUROTOMARIA NODULOSTRIATA.

*Plate* 32, *Fig.* 5.

*Pleurotomaria nodulostriata*, HALL. Trans. Alb. Inst., vol. 4, p. 21, 1856.
*Pleurotomaria nodulostriata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 80, pl. 9, fig. 5, 1882.

Shell turbinate; spire depressed-conical, obtuse at the apex; volutions about four, rounded, somewhat depressed above, the last one ventricose below; suture distinct, rather sharply defined; aperture sub-circular, slightly flattened on the inner side; umbilicus rudimentary, surface marked by strong, revolving, elevated striæ which are about equal to the spaces between them, excepting on the periphery of the outer volution where two or three are more distant, leaving a double spiral band; revolving striæ crossed by oblique striæ (parallel to the lines of growth) which are very conspicuous on the upper side of the volution, but become obsolete below the band. The revolving lines at the junction of the oblique striæ become nodulose on the upper half of the volution, and particularly near the suture.

Diameter .12 to .18; height .10 to .18 of an inch.

This little shell is distinguished by its depressed conical spire, which is almost truncate above. The external characteristics are the strong revolving striæ, only visible on the lower half of the last volution, or with but faint oblique striæ; while on the upper part of the volution, the crossings of the striæ produce a distinct nodulose or granulated surface; and this character is

the last to be obliterated in worn shells. The spiral band on the middle of the last volution consists of a single elevated line between two broad depressed spaces.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### PLEUROTOMARIA HUMILIS.

*Plate* 32, *Fig.* 3.

*Pleurotomaria humilis*, HALL. Trans. Alb. Inst., vol. iv, p. 21. 1856.
*Pleurotomaria humilis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 82, pl. 9, fig. 3. 1882.

Shell depressed, trochiform, oblique, spire a little elevated, consisting of three or four volutions which increase rapidly in size from the apex; volutions, depressed-convex above, and declining to the periphery; base of the last volution less convex than on the upper side, sub-obtusely angular on the periphery, which is marked by a narrow groove, which is but little wider than the usual spaces between the revolving striæ; surface marked by revolving and transverse striæ, which are stronger and more distant on the upper side of the volution, giving it a beautiful cancellated appearance; while they are closer and finer on the lower side of the shell; mouth transversely oval; umbilicus small.

Diameter, .10 to .19; height, .07 to .14 of an inch.

*Localities.*—Bloomington, Lanesville, and Spergen Hill, Ind.

### PLEUROTOMARIA MEEKANA.

*Plate* 32, *Figs.* 8, 9.

*Pleurotomaria meekana*, HALL. Trans. Alb. Inst., vol. iv, p. 22. 1856.
*Pleurotomaria? meekana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 82, pl. 9, figs. 8, 9. 1882.

Shell depressed-conical; spire short; rapidly diminishing and obtuse at the apex; volutions about five, appressed above and sub-angular below, with the periphery vertical; suture distinct; last volution large, not ventricose, biangular on the periphery, with a defined groove in the center which is distinctly margined above and below by an elevated line; surface on the upper side

of the volutions marked by revolving and transverse striæ of equal strength, which are regularly cancellated (and when not worn there is a slight nodosity at the crossing.)

The revolving lines on the base of the last volution are closer and finer than those above, and equally but less distinctly, crossed by the transverse lines which make a deep sinuosity on the periphery of the shell. Aperture sub-quadrate with a deep notch on the outer margin at the termination of the revolving band; umbilicus of medium size.

Diameter, .18; height, .13 of an inch.

This species resembles the *P. humilis* in general form; but the spire is more elevated, and it has one or two more volutions, which do not increase in size so rapidly as in that species. The periphery also is straight and bounded above and below by an angular ridge, and with a distinct spiral groove, margined on each side by an elevated band of equal width to itself, the three divisions occupying the whole of the periphery. The umbilicus is somewhat larger than in *P. humilis*, and the mouth more distinctly quadrate, its outer margin being nearly vertical.

*Locality.*—Erroneously cited in the original paper as occurring at Spergen Hill.

### PLEUROTOMARIA PIASAENSIS.

*Plate* 32, *Figs.* 6, 7.

*Pleurotomaria piasaensis*, HALL. Trans. Alb. Inst., vol. iv, p. 22. 1856.
*Pleurotomaria piasaensis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 83, pl. 9, figs. 6, 7. 1882.

Shell depressed, sub-globose; spire short and little elevated, consisting of about four volutions; volutions rapidly increasing in size, depressed-convex above, somewhat rounded below, and becoming sub-angular near the aperture; the periphery abruptly rounded and marked by a spiral groove or band; surface marked by about four strong spiral or revolving striæ on the upper side of the volution, between the periphery and suture, and four or five similar striæ on the lower side; transverse striæ scarcely distinct, except on the spaces between the revolving striæ; umbilical depression rather broad and margined by a strong angular elevation toward the aperture of the shell; aperture sub-

quadrangular, the pillar side shorter; the outer side, from the periphery to the angle bordering the umbilical region, nearly straight, and equal to the space from the periphery to the suture.

Diameter, .17; height, from .10 to .11 of an inch.

This species resembles *P. humilis* in form, but differs in the stronger revolving lines, with scarcely visible transverse striæ, and also in the decided angulation bordering the umbilical region.

*Locality.*—Piasa creek, above Alton, Ill.

### PLEUROTOMARIA SUBGLOBOSA.

*Plate* 32, *Fig.* 10.

*Pleurotomaria rotundata*, HALL. Trans. Alb. Inst., vol. iv, p. 23. 1856.
*Pleurotomaria subglobosa*, HALL. Cat. Am. Pal. Foss.; S. A. Miller, p. 245. 1877.
*Pleurotomaria subglobosa*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 79, pl. 9, fig. 10. 1882.

Shell sub-globose; volutions about five or six, convex, the last one very rotund or ventricose; suture distinctly marked, and the volution depressed just below it, and rising in an obtuse, undefined angle, below which is a distinct depressed revolving line, and below this again a similar sub-angular elevation, which forms the upper limit of the broad periphery of the outer volution, thus making the upper side of the volution obscurely biangular, with one depression between the angles and the other toward the suture. (These angles and the depression between are distinctly visible in the cast.) Aperture broadly ovate, umbilicus small; surface marked by fine, closely arranged revolving striæ; spire broad, depressed, conical.

Diameter, .09 to .45; height, .04 to .38 of an inch.

This is a well marked and easily distinguished species, both in external characters and in casts where the outer volution is preserved. The form is globose, the periphery of the last volution is a little straightened from the angle above. The two obscure angles and the depression between them characterize the species. No distinct striæ crossing the revolving striæ have been observed. There are some obscure indications of a spiral band on the periphery.

*Localities.*—Alton, Ill.; Spergen Hill, Bloomington, and Lanesville, Ind.

### PLEUROTOMARIA WORTHENI.

*Plate* 32, *Fig.* 4.

*Pleurotomaria Wortheni*, HALL. Trans. Alb. Inst., vol. iv, p. 23. 1856.
*Pleurotomaria Wortheni*, HALL. Geol. Rept. Iowa, p. 530, pl. 23; fig. 13. 1858.
*Pleurotomaria Wortheni*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 81, pl. 9, fig. 4. 1882.

Shell depressed sub-globose; spire but little elevated, oblique from the great expansion of the last volution; volutions about three, somewhat flattened above, rapidly expanding, so that the last volution makes nearly the whole bulk of the shell; obtusely angular on the periphery; upper margin of the volutions marked by a row of strong nodes, which extend about one-third across; surface marked above by striæ parallel to the lines of growth which on the last volution disappear in passing over the angulate periphery; base of last volution marked by strong revolving lines on the space between the outer margin and the umbilical area; base deeply excavated about the umbilical region, but the umbilicus is unknown. Aperture subquadrate, upper edge of the outer lip projecting far over the lower.

Diameter, .60; height, .48 of an inch.

In general form this species bears some resemblance to *P. sphærulata* of Conrad, (*P. coronula*, Hall,) but it has fewer volutions, it is less sharply angular on the periphery, and the nodes are much stronger and extend partially across the volution; while in *P. sphærulata* they are small and form an elevated crest along the suture line.

*Localities.*—Bloomington, Spergen Hill, and Lanesville, Ind.

### PLEUROTOMARIA SWALLOVANA.

*Plate* 32, *Figs.* 1, 2.

*Pleurotomaria Swallovana*, HALL. Trans. Alb. Inst., vol. iv, p. 24. 1856.
*Pleurotomaria Swallovana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 80, pl. 9, figs. 1, 2. 1882.

Shell depressed, somewhat globose, spire little elevated; volutions about five, regularly rounded, the last one sub-ventricose, and sometimes a little more expanded at the periphery; suture well defined; aperture sub-circular, a little oblique on the pillar;

umbilicus large, circular; a flattened band upon the periphery of the shell margined on each side by a distinct elevated line; volutions crossed by fine, even, thread-like striæ, which are smaller than the spaces between them, more conspicuous on the upper side of the volutions and often obsolete on the lower side.

Diameter, .12 to .25; height, .07 to .20 of an inch.

This species resembles a small Helix with depressed spire and large, rounded umbilicus. In worn specimens the striæ are often indistinct, and the revolving band on the periphery is frequently quite obliterated. When these are present, they afford, with the form, very reliable characters.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### PLEUROTOMARIA TRILINEATA.

*Plate* 32, *Fig.* 20.

*Pleurotomaria trilineata*, HALL. Trans. Alb. Inst., vol. iv, p. 25. 1856.
*Pleurotomaria trilineata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 80, pl. 9, fig. 20. 1882.

Shell ovate-conical; spire more or less elevated, acute at the apex; volutions about six; convex, last volution ventricose; suture distinctly defined; aperture sub-circular; columella perforate by a small umbilicus; surface marked upon the periphery by a comparatively broad spiral band, which is margined each side by a linear groove; two other similar grooves between the band and the umbilicus, dividing the base of the shell into three spaces, each one equaling in width the spiral band; entire surface, except the spiral band, ornamented by revolving thread-like striæ, which are crossed by fine lines of growth, the latter becoming stronger and curving slightly backward upon the spiral band; an almost imperceptible angulation just below the umbilicus.

Length, .25 to .50 of an inch.

In form, this shell somewhat resembles the *Cyclonema* (*Pleurotomaria*) *Leavenworthana*, but could only be mistaken for the same when occurring as casts. The distant revolving grooves on the lower part of the shell will readily distinguish it. In the better preserved condition, the finer revolving striæ, which

cover the surface, except the spiral band, together with this, are characteristic features. The spire in this species is also more acute than in the other, the volutions less uniformly rounded, and the last volution more ventricose, with a distinct umbilical perforation.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### PLEUROTOMARIA ELEGANTULA.

*Plate* 32, *Fig.* 19.

*Murchisonia elegantula*, HALL. Trans. Alb. Inst., vol. iv, p. 27. 1856.
*Pleurotomaria shumardi*, MEEK & WORTHEN. Geol. Surv. Ill., vol. ii, p. 260, pl. 18, fig. 6. 1866.
*Pleurotomaria elegantula*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 84, pl. 9, fig. 19. 1882.

Shell elongate-conical; spire composed of about six or seven volutions, which are obliquely flattened on the upper side, and angular near the base; suture not strongly defined, surface marked by strong elevated striæ which cross the volutions from the upper side obliquely, or with a gentle curve backward, and crossing the spiral band, which is coincident with the angle of the volution, appear below it in a nearly vertical, or slightly oblique, position to the axis of the shell; form of aperture unknown.

Length, .33 of an inch.

This very elegant little species differs from any of the others, in the strong transverse striæ, the angulation of the volutions near the lower edge, and the absence of revolving striæ.

The described specimen preserves but about six volutions, one or two having been broken from the apex.

*Locality.*—Bloomington, Spergen Hill, and Lanesville, Ind.

### PLEUROTOMARIA CONULA.

*Plate* 32, *Fig.* 17.

*Pleurotomaria (murchisonia?) conula*, HALL. Trans. Alb. Inst., vol. iv, p. 26. 1856.
*Pleurotomaria conula*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 84, pl. 9, fig. 17. 1882.

Shell conical, spire gradually and uniformly diminishing from the base; volutions six to eight, angular in the middle, and

flattened above and below; sutures defined; surface marked by distinct, elevated, nearly vertical striæ both above and below the spiral band; spiral band occupying the periphery of the volution, and composed of three revolving minute carinations with narrow depressions between (sometimes only two elevated bands are visible); aperture sub-quadrate; columella extended below, perforate.

Length, from .08 to .18 of an inch.

This shell is almost strictly conical, the volutions sub-angular, with nearly vertical, raised striæ, which are interrupted on the spiral band, and appear only slightly below or not at all. The spiral band sometimes appears to be composed of two raised striæ with a depression between, and sometimes of three striæ. The base is flattened toward the center, and prolonged into a short canal by the extension of the columella. It is quite distinct from all other species of this group in its gradually ascending spire, its centrally angular volutions, and elongate regularly conical form.

*Localities.*—Spergen Hill and Lanesville, Ind.

## MURCHISONIA, *Phillips.*

### MURCHISONIA INSCULPTA.

*Plate* 32, *Fig.* 18.

*Murchisonia insculpta*, HALL. Trans. Alb. Institute, vol. iv, p. 26. 1856.
*Murchisonia insculpta*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist. p. 85, pl. 9, fig. 18. 1882.

Shell subulate-conical; spire somewhat rapidly ascending, acute; volutions six or seven, convex and rounded in the middle, oppressed and sloping gradually above and abruptly below, to the suture; upper side of volutions marked by vertical elongate nodes, which are pointed above and gradually disappear in the surface below, or subdivided into distinct elevated striæ; spiral band rather broad, margined by two distinct elevated lines with the intermediate space convex or concave; last volution ventricose, extended below, and marked by an elevated line which is a continuation of the suture line; aperture somewhat rounded, and extended in front; columella extended below and imperforate.

Length, from .05 to .25 of an inch.

This shell resembles *Pleurotomaria* (*Murchisonia*) *conula* in general form, and in some degree in external characters; but it is less strictly conical, the volutions are more rotund in the middle, the spiral band broader and more elevated, never double, the last volution much more ventricose, and the columella imperforate. The nodes on the upper margin of each volution are triangular with the apex above, and appear as if sculptured from the substance of the shell, leaving similar equal reversed spaces between each. In some well preserved specimens, these nodes become diffused below in several strong, vertical striæ, which reach the spiral band. These do not reach the lower side of the volution, which sometimes shows a single elevated revolving line. The strong elevated line on the lower side of the last volution is also a distinguishing feature.

In fragments of the shell showing single volutions, the strong nodes are a distinguishing feature. Some specimens show remains of transverse or curved striæ, but in many this character is not observable.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### MURCHISONIA ATTENUATA.

*Plate* 32, *Fig.* 13.

*Murchisonia attenuata*, HALL. Trans. Alb. Inst., vol. iv, p. 27. 1856.
*Murchisonia attenuata*, HALL. Whitfield; Bulletin, 3, Am. Mus. Nat. Hist., p. 88, pl. 9, fig. 13. 1882.

Shell subulate, elongate; spire very gradually tapering; volutions nine or more, flattened; scarcely convex in the middle and marked by a spiral band which is margined on either side by a strong elevated carina; suture bounded on each side by a sharp elevated line, which is smaller than those bordering the spiral band; aperture transverse; umbilicus closed.

This shell is extremely elongate and attenuate; the volutions, though scarcely convex in the middle, have sometimes an angular appearance from the elevated striæ or carina bordering the spiral band. The only specimen in my collection is imperfect, and the full number of volutions and form of aperture are unknown. The only surface markings distinctly visi-

ble are the two strong lines bordering the band, and one above and below margining the suture, though they have probably been minute transverse striæ.

*Locality.*—Spergen Hill, Ind.

### MURCHISONIA VERMICULA.

*Plate* 32, *Fig.* 11.

*Murchisonia vermicula*, HALL. Trans. Alb. Inst., vol. iv, p. 27. 1856.
*Murchisonia vermicula*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 87, pl. 9, fig. 11. 1882.

Shell cylindrical, abruptly tapering at the apex; volutions from six to ten, moderately convex in the middle, and scarcely diminishing for the first four or five turns above the base, but becoming more abruptly contracted above; the surface of each volution marked by two very prominent revolving striæ, having a space between them on the periphery and a single finer line below, and one above near the suture; the last volution not ventricose, and marked by a fifth revolving striation, which is a continuation of the suture line; aperture broadly oval, rounded below; columella imperforate. Shell minute.

Length, .14 of an inch.

This shell is very similar to *M. attenuata*, but is much smaller and more cylindrical in form, and with more convex volutions which do not uniformly diminish toward the apex, as in that species. The surface markings are similar, but the convexity of the volution along the periphery offers a contrast with the flattened form of *M. attenuata*.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### MURCHISONIA TURRITELLA.

*Plate* 32, *Fig.* 12.

*Murchisonia turritella*, HALL. Trans. Alb. Inst., vol. iv, p. 27. 1856.
*Murchisonia turritella*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist, p. 88, pl. 9. fig. 12. 1882.

Shell subulate, elongate, gradually tapering to the apex; suture distinct; volutions about nine; equally rounded, the last

one slightly ventricose; surface marked by closely arranged, rounded, revolving striæ, which are stronger on the middle of the volution; fine revolving striæ on each volution of the spire, and about seven on the last volution; aperture sub-ovate; columella slightly extended and curved around the aperture imperforate.

Length, .18 to .50 of an inch.

This species has more resemblance to the genus TURRITELLA than to MURCHISONIA in its obvious characters, there being no distinct spiral band, nor variation in size of the revolving striæ. It is much larger than *M. vermicula* and readily distinguished by uniformly tapering from base to apex. There are no visible transverse striæ on our specimens.

*Locality.*—Spergen Hill, and Lanesville, Ind.

### MURCHISONIA TEREBRIFORMIS.

*Plate* 32, *Figs.* 15, 16.

*Murchisonia terebriformis*, HALL. Trans. Alb. Inst., vol. iv, p. 28. 1856.
*Murchisonia terebriformis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 86, pl. 9, figs. 15, 16. 1882.

Shell extremely elongate, subulate-acute; volutions eight or nine, very convex, marked by a broad spiral band in the center, last volution ventricose; suture deeply marked; surface ornamented on the upper side of the volutions by fine striæ; which extend obliquely backward to the spiral band; below the band by one or two spiral elevated striæ, and on the last volution by four or five similar striæ; aperture unknown; umbilicus closed.

Length, .33 of an inch.

This shell is distinguished by its extremely elongate and pointed form, with round, ventricose final volution. The periphery of the volutions above the last one is marked by a broad spiral band, while on the last it falls below the middle of the volution.

In form, this species resembles *M. turritella*, but it is a larger shell, and has no spiral lines above the band, while that species has four or five such striæ, differing from each other only in size. The volutions of that shell are less prominently rounded than in the present species.

*Localities.*—Bloomington, and Lanesville, Ind.

### MURCHISONIA VINCTA.

*Plate* 32, *Fig.* 14.

*Loxonema vincta*, HALL. Trans. Alb. Inst., vol. iv, p. 28. 1856.
*Murchisonia vincta*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 86, pl. 9, fig. 14. 1882.

Shell extremely elongate, very gradually tapering from the base; volutions convex below, appressed above, banded just below the suture, and marked by transverse arching striæ; aperture ovate, wider below; umbilicus closed.

Length, 1 inch.

The only specimen which I have seen of this species is a fragment, preserving the aperture imperfectly, with six volutions of the spire. The specimen has all the characters of Loxonema, in the general aspect of the shell, appression of the upper edge of the volution at the suture, etc. In this species there is a distinct obtuse carination just below the suture; the striæ are nearly obsolete in the present specimen from abrasion. On two or three of the volutions are found some appearances of varices, but in the worn condition it can not be known if they are of specific value.

*Locality*—Spergen Hill, Ind.

## CYCLONEMA, *Hall.*

### CYCLONEMA LEAVENWORTHANA.

*Plate* 31, *Figs.* 29-31.

*Pleurotomaria Leavenworthana*, HALL. Trans. Alb. Inst., vol. iv, p. 24. 1856.
*Cyclonema Leavenworthana* (Hall, sp.). Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 75, pl. 8, figs. 29–31. 1882.

Shell ranging in form from sub-globose to terete-conical and elongate-ovate; spire conical, varying greatly in its elevation from the young to the old shell; volutions five to seven, neatly rounded and ventricose below; suture well defined; aperture round-oval; umbilicus closed; surface marked by conspicuous, rounded, revolving striæ, which are less than the spaces between; striæ less conspicuous on the base of the last volution; the first line below the suture uniformly thinner and sharper than the others, and the spaces on each side wider.

Length, from .05 to .50 of an inch.

This species is very variable in form, depending apparently upon age; the young shell is much shorter, and the general form more globose. With age the spire becomes extended, and finally much elongated. There is no spiral band distinct from the revolving striæ; and in this respect the shell differs from the strict definition of PLEUROTOMARIA. In the elongated forms it is more like MURCHISONIA, from which it likewise differs in the absence of the spiral band.

*Localities.*—Alton, Ills.; Spergen Hill, Lanesville, and Bloomington, Ind.

### CYCLONEMA SUBANGULATUM.

*Plate* 31, *Fig.* 32.

*Pleurotomaria subangulata*, HALL. Trans. Alb. Inst., vol. iv, p. 25. 1856.
*Cyclonema subangulatum*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 76, pl. 8, fig. 3?. 1882.

Shell ovate-conical; volutions about five or six, angular above, the last one ventricose below; upper side of volution nearly rectangular to the direction of the spire; aperture ovate, the inner side straight or convex, umbilicus closed; suture distinct; surface ornamented by unequal, revolving lines, those on the lower part of the last volution finer and more closely arranged; three of those on the periphery stronger and more distant, the upper one of these three stronger than the other two forming the summit of the angle; midway between the angle and the suture is one strong angular striæ, and on the outer side, and sometimes on the inner side of this, a finer one.

Length, .35 of an inch.

This differs from any of the associated species in the angular form of the upper side of the volutions; while the revolving striæ are unequal in their size and distance from each other. There are some indications of finer revolving striæ between the coarser ones, which, in perfect shells may be distinct. In casts of this species the angular upper side is a distinguishing feature. This species resembles in form some varieties of *P. yvanii* of Leveille, and also in the angularity of the volution, but it has fewer and more irregular striæ, while in that species

they are represented as regular and numerous. No striæ parallel to the lines of growth have been observed, though doubtless they were present originally.

*Localities.*—Spergen Hill, and Lanesville, Ind.

## LOXONEMA, *Phillips.*

### LOXONEMA YANDELLANA.

*Plate* 31, *Figs.* 35, 36.

*Loxonema yandellana*, HALL. Trans. Alb. Inst., vol. iv, p. 28. 1856.
*Loxonema yandellana*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 77, pl, 8, figs. 35, 36. 1882.

Shell terete-subulate; spire elongate, very gradually tapering to the apex, which is apparently obtuse; volutions about eight or nine, very little convex, the last one scarcely expanded; suture distinct; surface marked by fine thread-like striæ crossing the volutions with a slight undulation above the middle; aperture ovate.

Length, .20 to .50 of an inch.

This species has a delicate subulate-terete form, the volutions very gradually increasing to the base, the last one is scarcely more expanded than those above. It is readily distinguished from any other form here described.

*Locality.*—Spergen Hill, Ind.

## EOTROCHUS, *Whitfield.*

### EOTROCHUS CONCAVUS.

*Plate* 32, *Figs.* 21–23.

*Pleurotomaria concava*, HALL. Trans. Alb. Inst., vol. iv, p. 24. 1856. (Name preoccupied.)
*Pleurotomaria tenuimarginata*, HALL. S. A. Miller; Cat. Am. Pal. Foss., p. 245. 1877.
*Eotrochus concavus* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 78. pl. 9, figs. 21–23. 1882.

Shell trochiform; spire depressed-conical; volutions about five, flattened or slightly concave above; base of shell concave; periphery alate, alation curving downward at the margin; aperture transversely ovate (the wider part at the pillar); umbilicus

of medium size, round; suture linear, rather indistinct; surface smooth or marked by obsolescent striæ, which turn abruptly backward from the suture to the periphery; similar striæ are sometimes visible on the base of the shell, bending abruptly backward on the alation.

Diameter, .25 to .75 of an inch; height, from .20 to near .50 of an inch.

The umbilicus is somewhat distinctly margined, the upper sutures are often obsolete (perhaps from wearing), and the striæ are usually but faintly visible.

If the last volution were inflated, the alation would form a distinct carination or elevated spiral band upon the periphery, presenting the characteristics of the genus, but in its present condition the shell might with almost equal propriety be referred to TROCHUS, or to the typical species of the genus STRAPAROLLUS.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## BULIMORPHA, *Whitfield.* 1882.

**Bulimella*, HALL. 1856.—Not Pfeiffer, 1852.

Shell fusiform or sub-fusiform (elongate); volutions of moderate convexity, the last one much enlarged; columella truncate, outer lip with a slight notch or sinus at the margin near its junction with the pillar.

The three species here described have their nearest analogies with BULIMUS and ACHATINA so far as I can at present determine. The shells can not be satisfactorily referred to any established genus.

### BULIMORPHA BULIMIFORMIS.

*Plate* 31, *Figs.* 37–39.

*Bulimella bulimiformis*, HALL. Trans. Alb. Inst., vol. iv, p. 29. 1856.
*Polyphemopsis bulimiformis*, HALL. M. & W.; Geol. Rept. Ill., vol. ii, p. 372. 1866.
*Bulimorpha bulimiformis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 74, pl. 8, figs. 37–39. 1882.

Shell fusiform elongate; spire nearly equal to half the length

[*This generic name was preoccupied by Pfeiffer in 1852, as pointed out by Meek & Worthen in 1866, (Geological Report of Illinois, vol. ii, p. 372,) and was by them referred to the genus Polyphemopsis of Portlock.]

of the entire shell; volutions about six, slightly convex in the middle, increasing somewhat rapidly, the last one equaling in length all the others; aperture elongate-oval, acute at each extremity slightly sinuate at the upper outer angle; columella slightly curved, and truncate at the base, surface smooth or with faint lines of growth.

Length, .125 to .75 of an inch.

*Locality.*—Spergen Hill, Lanesville, and Bloomington, Ind.

### BULIMORPHA CANALICULATA.

*Plate* 31, *Fig.* 41.

*Bulimella canaliculata*, HALL: Trans. Alb. Inst., vol. iv, p. 29. 1856.
*Polyphemopsis canaliculata*, HALL. M. and W.; Geol. Rept. Ill., vol. ii, p. 372. 1866,
*Bulimorpha canaliculata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 74. pl. 8, fig. 41. 1882.

Shell sub-fusiform, somewhat elongate; spire short, scarcely equaling the length of the last volution; volutions about five, upper ones scarcely convex, rapidly diminishing to the apex; last volution longer than the spire above, slightly ventricose; suture canaliculate, the groove margined by a slight sharp carination at the upper edge of the volution; aperture, sub-ovate; surface smooth, or marked with fine lines of growth, which are abruptly bent backward at the carination on the upper edge of the volution, which marks the notch in the upper angle of the aperture.

Length, .18 of an inch.

This species differs from *B. bulimiformis* in the canaliculate suture and conspicuous carination on the upper edge of the volution. The spire is shorter in proportion to the last volution, and it has apparently one volution less. The surface markings are obscure, but the position of the lines of growth, and their abrupt backward bending upon the upper edge of the volution, show their direction.

*Localities.*—Spergen Hill, and Lanesville, Ind.

### BULIMORPHA ELONGATA.

*Plate* 31, *Figs.* 40.

*Bulimella elongata*, HALL. Trans. Alb. Inst., vol. iv, p. 30. 1856.
*Polyphemopsis elongata*, HALL. M. and W.; Geol. Rep. Ill., vol. 2, p. 372, 1866.
*Polyphemopsis teretiformis*, HALL. Cat. Am. Pal. Foss. S. A. Miller, p. 245. 1877.
*Bulimorpha elongata* (Hall, sp.) Whitfield; Bulletin 3, Am., Mus. Nat. Hist., p. 75, pl. 8, fig. 40. 1882.

Shell extremely elongate; volutions seven or eight (perhaps nine), somewhat rapidly ascending, moderately convex, the greatest convexity a little above the middle, last one slightly ventricose; suture distinct; an undefined angular elevation below, corresponding to the notch in the lip; surface nearly smooth; direction of the striæ scarcely visible.

Length .50 of an inch.

This species is distinguished from the others chiefly by the greater number of volutions, more elongate spire, and proportionally smaller body volution. The surface, as in the others, is nearly smooth, and the direction of the striæ scarcely visible.

*Locality.*—Spergen Hill, and Lanesville, Ind.

## HOLOPEA, *Hall.*

### HOLOPEA PROUTANA.

*Plate* 31, *Figs.* 33–34.

*Holopea Proutana*, HALL. Trans. Alb. Inst., vol. iv., p. 30. 1856.
*Holopea (Callonema?) Proutana* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 72, pl. 8, figs. 33, 34. 1882.

Shell ovate-conical; spire somewhat rapidly tapering; volutions about six; moderately convex, last one ventricose, subangular in the direction of the suture line, and obliquely extended below; suture sharply defined; aperture round-ovate, oblique on the upper side; pillar lip slightly reflexed in the umbilical region; umbilicus closed; surface marked by fine striæ parallel to the lines of growth.

Length .062 to .50 of an inch.

This shell has the apperance of a small PALUDINA, which is indeed the general aspect of the species of this genus. The last volution is ventricose and extended in front; the higher volu-

tions of the spire are moderately convex, the greatest convexity being in the middle or slightly below. The last volution shows an obtuse undefined angle in continuation of the suture line. No revolving striæ are visible upon the surface.

*Localities.*—Alton, Ill.; Spergen Hill, Lanesville, and Bloomington, Ind.

## MACROCHEILUS, *Phillips.*

### MACROCHEILUS? LITTONANUS.

*Plate* 31, *Fig.* 28.

*Natica Littonana*, HALL. Trans. Alb. Inst., vol. iv, p. 30. 1856.
*Macrocheilus Littonana* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 72, pl. 8, fig. 28. 1882.

Shell short, sub-fusiform; spire depressed-conical; volutions about four, rapidly increasing from the apex, the last volution symmetrically ventricose and prolonged below; suture not strongly marked; aperture narrow-ovate, sharp above, and narrowing near the front; outer lip thin; inner lip thickened; surface striated.

Height, .25; diameter, .19; last volution, .17 of an inch.

This shell bears a near resemblance to *Littorina pusilla* of McCoy (Carb. Foss. of Ireland, p. 32, pl. 5, fig. 26), but that shell is somewhat more elongate, with a higher spire, while the aperture is broader below, the pillar lip more arched near the front. In the present species the body volution is also a little more ventricose.

*Locality.*—Bloomington, Ind.

## NATICOPSIS, *McCoy.*

### NATICOPSIS CARLEYANA.

*Plate* 31, *Figs.* 26, 27.

*Natica Carleyana*, HALL. Trans. Alb. Inst., vol. iv, p. 31. 1856.
*Naticopsis Carleyana* (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 71, pl. 8, figs. 26, 27. 1882.

Shell sub-globose; spire short, consisting of about three volutions, which increase very rapidly, the last one extremely ventri-

cose; suture not distinctly defined; aperture ovate, straight on the columella side; outer lip sharp; inner lip thickened; columella with a distinct groove near the base of the lip for the reception of the operculum; surface marked by fine, elevated striæ corresponding to the lines of growth.

Height, .10 to .30; diameter, .08 to .34 of an inch.

This little shell has the external character and general appearance of the genus NATICA, but differs in the absence of an umbilicus. In this respect it corresponds to the genus NATICOPSIS, as described by McCoy.

The shell is quite distinct in character from all others in this formation, except its congener, which has a higher spire and narrower aperture. Many of the specimens are worn quite smooth, and afford but faint traces of the striæ; and only in a few instances, near the suture, are they preserved in a perfect condition.

*Localities.*—Alton, Ills.; Spergen Hill and Bloomington, Ind.

## PLATYCERAS, *Conrad.*

### PLATYCERAS ACUTIROSTRIS.

*Plate* 31, *Figs.* 13, 15.

*Capulus acutirostris*, HALL. Trans. Alb. Inst., vol. iv, p. 31. 1856.
*Capulus acutirostris*, HALL. Geol. Rept. Iowa, p. 665, pl. 23, figs. 14. 1858.
*Platyceras acutirostris*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 67, pl. 8, figs. 13, 15. 1882.

Shell obliquely conical, more abruptly contracted above, and continued in more slender proportions to the apex, which is incurved, making about a single volution without contact with the body of the shell; aperture sub-circular, margin sinuate; surface sub-plicate, with narrow sub-angular folds and wider depressed spaces; lines of growth strong, abrupt upon the angles, and arching forward on the spaces between.

This species is not remarkably different from others of the same genus in the Carboniferous and Devonian rocks. The apex, however, is more slender, and the arching of the striæ on the surface is more extreme than I have observed in species of this form.

In other specimens the elevated folds and wide depressions do not alternate regularly, and the surface is unequally plicate or undulating.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## BELLEROPHON, *Montfort.*

### BELLEROPHON SUBLÆVIS.

*Plate* 31, *Figs.* 6, 7.

*Bellerophon sublævis*, HALL. Trans. Alb. Inst., vol. iv, p. 32. 1856.
*Bellerophon sublævis*, HALL. Geol. Iowa, p. 666, pl. 23, fig. 15. 1858.
*Bellerophon sublævis*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 89, pl. 8, figs. 6, 7. 1882.

Shell sub-globose, inflated on the last volution; aperture transverse, arcuate, expanded, the lip thickened and much extended at the junction with the volution; umbilicus closed; dorsum carinated by a narrow slightly elevated carina; surface ornamented by fine, regular striæ which bend abruptly and deeply backward on the carina, denoting the depths of the emargination of the lip; striæ sometimes irregular from interrupted growth.

Length, from half to one inch.

This shell differs from the preceding in its larger size, and more globose character of the outer volution, exhibiting no flattening across the dorsum. It differs also in the absence of longitudinal striæ and umbilicus. In worn specimens the striæ and carina are often quite obliterated; and the general form of the shell is the only guide to its specific distinction.

*Localities.*—Alton, Ill.; Spergen Hill, Lanesville, and Bloomington, Ind.

### BELLEROPHON TEXTILIS.

*Plate* 31, *Figs.* 4, 5.

*Bellerophon cancellatus*, HALL. Trans. Alb. Inst., vol. iv, p. 31. 1856.
*Bellerophon textilis*, HALL. Cat. Am. Pal. Foss., S. A. Miller. 1877.
*Bellerophon textilis*, (Hall, sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 90, pl. 8, figs. 4, 5. 1882.

Shell sub-globose; aperture transversely oval, arcuate, with the lip reflexed at the sides; umbilicus small in young shells,

and scarcely visible in the older specimens from the thickening of the lip; surface marked by fine longitudinal reflected striæ, of which about thirty may be counted on each side of the carina increasing by implantation with the age of the shell; carina rather narrow and little elevated, very indistinctly marked by the longitudinal striæ. Transverse striæ, in the direction of the lines of growth, irregular, sub-imbricate, more distant than the longitudinal striæ, bending backward on the carina. At the crossing of the two sets of striæ the surface is slightly nodulose, in well preserved specimens.

Length, .125 to .75 of an inch or more.

This beautiful species resembles the *B. decussata* of Fleming; and it is with some hesitation that I propose a different designation. But our shell is less distinctly umbilicate; and both the longitudinal and transverse striæ appear to be closer in that species than in this one, while the spiral band is narrower and less conspicuous, and is faintly marked by three of the longitudinal striæ. In our species the transverse striæ likewise bend more abruptly backward on the carina, than is represented in *B. decussata*.

*Localities.*—Spergen Hill, Lanesville, and Bloomington, Ind.

## PTEROPODA.

### CONULARIA, *Miller.*

#### CONULARIA SUBULATA.

*Plate* 31, *Fig.* 3.

*Conularia subulata*, HALL. Trans. Alb. Inst., vol. iv, p. 32. 1856.
*Conularia subulata*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 91, pl. 8, fig. 3. 1882.

Shell quadrangular, the four sides nearly flat, and converging at an angle of about 18°; surface marked with a distinct longitudinal groove on each of the angles, and numerous regular, smooth, closely-arranged, elevated, transverse striæ, which pass a little obliquely downward toward the middle of each of the sides, when they meet at a very obtuse angle. A single sharp

longitudinal line passes down the center of each side, without interrupting the transverse striæ; angles truncate or rounded toward the apex.

Length, .50 of an inch.

*Locality.*—Alton, Ill.

## CEPHALOPODA.

### NAUTILUS, *Breyn.*

#### NAUTILUS CLARKANUS.

*Plate* 31, *Fig.* 1.

*Nautilus clarkanus*, HALL. Trans. Alb. Inst., vol. iv, p. 32. 1856.
*Nautilus clarkanus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 92, pl. 8, fig. 1. 1882.

Shell sub-discoidal, flattened on the dorsum [ventrum], and angular at its lateral margin; umbilicus large, showing all the inner volutions; volutions (number unkown) rapidly diminishing, broader than high, not embracing; surface ornamented by a deep revolving groove round the dorso-lateral [ventro-lateral] margin, between which and the umbilicus, is a single row of indistinct nodes, and about five or six strong striæ, which are crossed by fine elevated striæ. Aperture transversely oval; septa slightly concave, and separated by spaces about equal to one-fourth the greater diameter of the volutions.

The specimens described is somewhat worn upon the dorsal [ventral] side, which may have obliterated the fine transverse or longitudinal striæ, remaining upon the lateral edge of the shell.

*Localities.*—Spergen Hill, and Lanesville, Ind.

### ORTHOCERAS, *Breyn.*

#### ORTHOCERAS EPIGRUS.

*Plate* 31, *Fig*, 2.

*Orthoceras epigrus*, HALL. Trans. Alb. Inst., vol. iv, p. 33. 1856.
*Orthoceras epigrus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 91, pl. 8, fig. 2. 1882.

Shell sub-cylindrical, very gradually tapering; section circu-

lar; siphuncle small, sub-central; septa slightly concave, separated by spaces equal to about one-third the diameter of the shell; surface marked by distant, rather faint, longitudinal lines.

This species resembles *O. munsterianum* of de Koninck, but it is much smaller, less tapering, and has more distant septa. It also appears to differ in the surface markings, having traces of faint longitudinal lines, while that species is smooth.

*Locality.*—Spergen Hill, and Lanesville, Ind.

## ANNELIDA.

### SPIRORBIS, *Lamarck.*

#### SPIRORBIS ANNULATUS.

*Plate* 32, *Fig.* 30.

*Spirorbis annulatus*, HALL. Trans. Alb. Inst., vol. iv, p. 34. 1856.
*Spirorbis annulatus*, HALL. Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 92, pl. 9, fig. 30. 1882.

Shell planorbicular, more or less ascending, irregular, spiral; spire composed of about three turns, which are contiguous or more or less disconnected; umbilical side more or less deep and regular, according to the regularity of the spiral; surface ornamented with strong annulations, with finer striæ between.

Diameter from .062 to .25 of an inch.

This species, like others of the genus, is very irregular in its convolutions, being sometimes almost entirely disjoined. The two first volutions are often in the same plane, while the succeeding one becomes deflected or extremely irregular. Some individuals are quite regular throughout. In worn specimens the annulations are partially worn off, and appear only as transverse nodes upon the surface.

*Localities.*—Alton, Ill.; Spergen Hill, Bloomington, and Lanesville, Ind.

### SPIRORBIS NODULOSUS.

*Plate* 32, *Fig.* 31.

*Spirorbis annulatus*, var. *nodulosus*, HALL. Trans. Alb. Inst., vol. iv, p. 34. 1856.
*Spirorbis nodulosus* (Hall sp.) Whitfield, Bulletin 3, Am. Mus. Nat. Hist., p. 93, pl. 9, fig. 31. 1882.

Shell in form like the preceding; last volution strongly deflected; volutions sub-angular, marked by oblique striæ or ridges, which become strongly nodulose on the umbilical side, and particularly towards the aperture.

*Locality.*—Spergen Hill, and Lanesville, Ind.

## CRUSTACEA.

### LEPERDITIA, *Roualt.*

### LEPERDITIA CARBONARIA.

*Plate* 32, *Figs.* 24, 27.

*Cythere* (misprint for *Cytherina*) *Carbonaria*, HALL. Trans. Alb. Inst., vol. iv, p. 33. 1856.
*Leperditia Carbonaria* (Hall sp.) Whitfield; Bulletin 3, Am. Mus. Nat. Hist., p. 94, pl. 9, figs. 24, 27. 1882.

Shell oval or sub-ovate, gibbous, slightly compressed toward the margins, ventral [dorsal] margins straight, one-third less than the greatest length of the valves; extremities rounded, broader anteriorly; dorsal [ventral] margin forming a broad curve; surface smooth.

This species does not exceed a single line in length. Compare with *C. pusilla*, McCoy.

*Localities.*—Spergen Hill, Bloomington, and Lanesville, Ind.

# DIATOMACEÆ.

## DIATOMS OF THE WATERS OF INDIANA.

BY REV. GEO. L. CURTISS, M. D., D. D.

The microscopist very soon finds in all waters, salt and fresh, an innumerable host of exceedingly small, beautifully marked, and singularly shaped microscopical bodies, which have received the general name, Diatom. They form the "last division of the Algæ group, and occupy the same relation to vegetables as do the infusoria to the animal kingdom." What is usually seen by the microscopist is only the shell of the diatom, composed of pure silicon. There are two shells inclosing the vegetable matter, called the frustrules, "between which is the small connective band which divides the body into two parts." In the interior is the endochrome or coloring matter, usually of a yellowish brown color or a deep green, with a few oil drops, either clear or of a slightly yellow-brown. These oil drops are not always present.

Diatoms are found extensively in fresh and salt water. A few are common to both. Those from salt water are usually larger than those from fresh water, but are not any more beautiful to the eye or interesting to the naturalist.

It was once supposed that the salt water possessed many more and richer varieties than the fresh, but late investigations show that old ponds, lagoons and bayous of our Western rivers are as rich in varieties, having as delicate and intricate markings as any portion of the ocean. Running brooks are fine places to find varieties not inhabiting still water, while the clear and purling waters of the springs of our county furnish varieties equaling any in delicacy and beauty.

As fossil, diatoms are found in abundance such as to render them an important factor in the study of the minute structure of the rocks. At Blin, in Bohemia, is a bed of diatoms 130 feet thick. They are mostly of the kind known as "*Navicula*," and exist in numbers beyond calculation. At Planitz, Saxony, exists a bed of fresh water diatoms, showing that in earlier geological ages there were immense fresh water ponds, as now. The city of Berlin rests on a clayey peat 60 feet thick, composed of diatom fragments. At "Wismar, on the Baltic, there is deposited every year, as appears from official documents, 228,854 cubic feet of mud, and the accumulation has continued at this rate for more than a hundred years." These mud banks were found by Ehrenbergh to present "on an average one-tenth part of the entire mass" of diatoms, partly living and partly only the shells. At this rate the annual deposit of diatoms at Wismar was 22,885 cubic feet. "In the mud banks of Pillau the remains of diatoms were found to be in greater abundance than in those of Wismar." The mud deposited by the Elbe is nearly one-half the flinty shells of diatoms. "A mud bank in Victoria Land, 400 miles long and 120 broad, is composed of silicious valves of diatoms."

Along the Atlantic coast of the United States the same thing has been observed. At Boston harbor, in the marine marshes and around New Haven, Conn., also in the marshes of Amboy, N. J., the same prevalence of diatoms is observed. Richmond and Petersburgh, Va., are built on diatom beds 18 feet thick. Lake Boa, in the Island of Mull, Scotland, furnished Prof. Gregory with 130 new species. Prof. Bailey discovered, near West Point, a remarkable layer or deposit of fossil diatom. "This deposit," he says, "is about a foot below the surface of a small peat bog, immediately at the foot of the southern escarpment of the hill on which the celebrated Fort Putnam stands. In draining this bog a large ditch was dug, and among the matter thrown out my attention was attracted by a very light white or clay-colored substance, which, when examined closely in the sunshine, showed minute, glimmering, linear particles. On submitting it to observation, by means of a good microscope, I found it to be almost entirely composed of fossil organisms," a large portion being diatoms.

You may take fish from either salt or fresh water, and exam-

ine the contents of the stomach by the microscope, and in most cases there will be found quantities of diatoms, unaffected by the process of digestion. How the fish utilizes diatoms in growth we can not tell, but that they are found in the fish has often been demonstrated.

The guano imported from the southern islands, and so largely employed for fertilizing, is found to contain immense numbers of "diatomaceous structures of great elegance and richness, and, as we gaze upon these minute cases, we can not fail of being struck with the fact of the great resistance to decomposition which they possess. In this instance they must have gone through the process of digestion twice, and been subjected to the action of the elements for centuries," guano being the droppings of birds after feeding upon the fish which had fed upon the diatoms. "But under all these influences they continue unchanged, and the eye of the naturalist at last detects these minute structures still possessing their original beauty, with the delicate tracery of their rich configurations, almost as sharp and clear as it was, perhaps, a thousand years ago."

Let us go out to a pond or marsh in any portion of Indiana and see what will come to our glass. We will find more or less green scum growing on the water, besides a great variety of short hairs or masses of sponge-like substance attached to sticks and stones in the water. There will be long, green, waving filaments, noticeable for their slenderness, and a slimy or gelatinous substance, holding to everything in the water. The green scum is one form of Algæ, a most delicate vegetable of the Cryptogamic form. The waving or oscillating filaments are another kind of Algæ. The sponge-like substance is still another form of Algæ, while attached to, and growing more as a parasite to the Algæ, there may be found another vegetable called the Diatom, though classed with the Algæ. In the slimy, gelatinous substance will be found also diatoms of almost endless variety. The mud deposit of these ponds will be found composed of an average of forty per cent. of Diatom shells, from which they may be readily separated by various processes for examination. The variety of forms and markings arrest attention, and the inquirer studies the character of these little things with an ever increasing wonder.

Take a portion of water known to contain a large number of Diatoms, pour in a small quantity of nitric or sulphuric acid and boil for some minutes. Wash out the acid remaining, and place a drop of this water on a slide under the microscope and you discover the shell cleaned of all foreign substances and remaining as bright and beautiful as if no corroding acid had ever been placed upon it. If, into the water containing Diatoms hydro-fluoric acid is dropped and allowed to stand for a time, "the cellular membrane of vegetable nature is formed beneath, having the same striæ and design as the silicious coat." May we not have here the secret of the Diatom growth? The vegetable bioplasm, endowed by its Creator with its distinctive powers, grows with its individual striæ and markings, eliminating from the water that kind of matter which is silicious, suitable for its protection, and causes it to deposit upon itself with its own individual markings. The shell thus formed becomes a shield for protection to the delicate algæ it encloses.

"The Academy of Genoa has published a paper by Count Castrea," says a recent number of the *Journal of Microscopy*, "on the importance of diatoms in the formation of the earth's crust. Owing to the indestructible nature of their shells, the author believes that fossil diatoms enable him to demonstrate that in the vegetable kingdom 'the fixity of species is a constant law.'"

The most casual observer can not but discover the striking resemblance between diatoms known to be fossil, and those of the present growth.

A careful study of diatoms, ancient and modern, fossil and recent, reveals the fact that the laws of nature as to chemistry, vegetable life, form and relations, are the same, though separated by thousands of years. If this were not so, we should expect to find between diatoms of ages ago differences so marked, when subjected to the action of laws of to-day, that the tyro in observation could see them. But as it is, the most careful and rigid examination and subjection to tests, both chemical and microscopical, reveal no differences, save in an endless variety of markings and forms. The mathematics of God knows no variable quantity.

The movement of diatoms is a phenomenon not fully ex-

plained. The microscopist, when viewing diatoms fresh from the water, will not fail to observe that some of them have a considerable motion, moving forward and backward, and turning completely around, as if moved by force of will. It was this movement that led earlier students to class these as infusoria. It is now pretty well established that they are vegetable bodies, covered with plates of silex. But the movement is something difficult of explanation. I have found that most of the moving diatoms are surrounded by a cloud of jelly, and sometimes a number of small cilia are seen attached to the edges, and have at times a slight movement. These pseudocilia are not always present. Even when absent the diatom may move. When diatoms have been boiled either in clear water or in acid, they lose the flocculent matter surrounding them, and possibly in which they grow, and at the same time lose the power of locomotion. This fact, often observed, leads me to believe that the jelly surrounding the nidus is in some way the cause of the movement of diatoms.

Dr. Max Schultze, of Bonn, takes the position that the presence of oil globules in the diatom may, by its repulsion, account in part for this movement. That there exists oil globules can not well be disputed, after the results of his continued experiments. He thinks that these, by repelling the water, may thus proceed through the water. Dr. Schultze expresses doubt as to a free motion of diatoms in water, unless they can touch something by their raphæ or midrib by which it has resistance afforded sufficient to cause true motion. He thinks the motion is due to coming in contact with the cover glass, or the slide with its raphæ. I hardly think this can be so, for having placed *naviculas* in a watch crystal, I have examined them when no cover glass could come in contact with the diatom, and during such times have seen the movements nearly or quite as marked as when under a cover glass.

Since writing the above, I find that Dr. Schultze speaks of the existence of this jelly-like cloud around most diatoms in a natural state, and calls it the "sarcode," but does not attribute to it very great influence in the movements.

Professor Smith, of America, has observed and traced the outline of this "sarcode." A microscopist at Buffalo, N. Y., has made some interesting observations on the movements of

diatoms in the Niagara waters, which harmonize with the theory of motion dependent upon the jelly-like substance surrounding the body of the diatom.

There are some diatoms common to all ponds, running streams, lakes, seas and oceans. They seem to be cosmopolitan. These are usually found among the Navicula, Fragilaria, Synedra and Pleurosigma. They are found in all waters, in all zones, and exist as fossil and recent. But each locality will reveal some diatoms peculiar to itself, and which may be taken as indigenous to that particular water. Samples of water from various ponds and streams of Indiana reveal a variety of diatoms as great as any State in this Union, or possibly any country on the globe. Dr. Van Heurck has published engravings of 1,700 different varieties of diatoms found in the waters of Belgium; and still that industrious microscopist and his able assistants are finding new varieties almost each week. It may be confidently affirmed that the waters of Indiana are as rich in diatoms, and present as many varieties, as do the waters of Belgium. The diligent microscopists of Indiana need not long for the sweet waters of other countries to employ their time in examinations when the waters of their own State are teeming with beauties waiting to be found and studied. It may sound grand, and have a smack of learning, to say: "I have in my cabinet water with specimens from the Baltic, the Nile, or the Elbe," but it will sound more like home research and hearty love for making contribution to science when the microscopist can say: "I have specimens from the Wabash, the Maumee, the White Water, the Sugar Creek, Missisinewa, the Muscatatuck, the Ohio, and the hydrants of Indianapolis."

Diatoms live and grow at all seasons of the year. Cold may possibly retard growth and multiplication, but does not stop either. From the hydrant located at the corner of South and East streets, Indianapolis, during the cold winter of 1880 and 1881, I took specimens nearly every day of the season. At no time did I go there for specimens of algæ and infusoria but I found them in abundance, accompanied always by great numbers of diatoms in a fresh, growing state. I have taken them from water that was freezing cold, which could not congeal because it was flowing from the bowl of the fountain, and still they were as frisky as ever.

"What may be the benefit derived from a thorough study of these infinitessimal bodies?" is asked by the would-be utilitarian. The answer is three-fold:

1. It is educational to know what exists around us. We may have been led to suppose that only those things are noble and valuable that can be seen by the unaided eye. The microscope reveals even as beautiful, if not more beautiful, things in the lesser world, and so the mind and heart are led to a higher education.

2. The study of diatoms reveals clearly and undisputably the unity of the laws of nature. The laws controlling in the geological ages were the same as are existing in the present age. The mind that planned and executed then is planning and executing now. Nature has never been given over to unguided and lawless forces, but He who first took the reins of government, and guided the material universe, continues in the same work. The demonstration of this one discovery alone is reward enough for all the labor, money, patience and time put into its study.

3. There is some connection between the immense quantities of diatoms in pond water and the fertilization of soil by alluvial deposits. Ehrenberg found that the earth washed down by the Nile and spread out over the Delta of Egypt was composed largely of diatoms. It has long been known that bottom lands overflown by the flooded river or creek become thereby exceedingly rich. On examination, diatoms are present in great abundance. The draining of a pond leaves rich and productive soil, wherein diatoms form no small part of the deposit. Just how diatoms become a source of wealth, or act as a fertilizer, has not been discovered, but that they are such, can not be disproved.

Indiana diatoms possess a special interest to microscopists of the State. I present herewith carefully executed drawings from the microscope of 104 varieties of fresh water diatoms, taken from the hydrant and pond waters in and around Indianapolis, within a radius of four miles, except four specimens which were obtained in the waters at Shelbyville, Greenwood and Zionsville, Indiana. Could the same kind of careful examination and drawings be made of the various localities of Indiana, there is no telling what would be the revelations. Our waters are not poverty stricken as to intensely interesting

objects of natural history, but they are rich in material. When turning our attention to this field, we may say with one of old, "The half has not been told." What is here presented, it is hoped, will be only a pioneer work to what may follow when properly encouraged.

In the prosecution of this work I have been greatly aided by Dr. J. M. Mansfield, of Indiana Asbury University, who kindly loaned me "The Synopsis of Diatoms of Belgium, by Dr. Van Heurck, published in parts, commencing in 1880." This recent work is the most valuable of all that were consulted, because of its simplicity and accuracy.

Dr. F. S. Newcomer, of Indianapolis, an enthusiast in microscopical studies, aided greatly in obtaining classification and names, and in testing the work by loaning me his "Diatomacean-Typen-Platte," of J. D. Moller. The value of this "Platte" as a test of work done is beyond estimate.

In the Indiana State Library I also found "A. Schmidt's Atlas der Diatomaceenkunde," though this did not prove so valuable an aid as the work of Van Heurck in the nomenclature, yet in its geographical department it is excellent.

From Hon. T. B. Redding, Ph. D., of New Castle, Ind., an expert microscopist, I received from time to time important suggestions and words of encouragement.

At last, the drawings were put into the hands of C. M. Vorce, of Cleveland, O., a gentleman every way competent to examine and decide upon the correctness of such work. His copious notes and suggestions have been carefully studied, and mainly adapted and made a part of the work.

In this Synopsis of Diatoms of Indiana, I have adhered rigidly to a scale of 450 to 500 diameters, except in a few instances, where in the explanations I have noted higher powers. My reason for so doing was to furnish something that the younger microscopist can use to advantage. Most persons pursuing this study can obtain an objective giving from 400 to 500 diameters, but comparatively few can or will obtain higher powers. For this reason, it seemed preferable to bring this study to a line which might be made beneficial to others.